THE MEDICAL JOURNAL OF AUSTRALIA

VOL. II. 29TH YEAR. SYDNEY, SATURDAY, AUGUST 8, 1942. No. 6.

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THE COLLECTION AND STORAGE OF BLOOD, BLOOD SERUM AND BLOOD PLASMA.[1]

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MY purpose is to outline as briefly as possible some of the principles underlying much that has been done—principles which are still believed to have application in the present and the future. Particularly, however, I desire to leave a sufficiency of time for us all to hear in detail the experiences of those men we are privileged to have with us tonight, who have been in action, who have used this system of transfusion, and who can tell us whether it works or whether it does not, and why and how.

Those of us who were confronted in the early days of the war with the problem of providing for intravenous therapy in the services were given an open problem. The practice of medicine and surgery at that time included the liberal use of physiological solutions and of blood transfusion, and there was some mention (and a very limited practice) of the transfusion of plasma and serum. We had to decide which of these things must be given in the services, in what form, and to what extent. An attempt was made to return to first principles, and I should like to go briefly over those first principles, in the hope that they will serve as something of a skeleton on which the rest of the discussion may hang.

Blood transfusion should be considered first, because of its obvious association with wounds and the loss of blood. Before the war blood transfusion had been successfully practised for some years by methods classified as direct and indirect. The direct method began as a rather difficult procedure, in which fresh blood was withdrawn into apparatus having specially prepared surfaces to avoid or reduce clotting, and was injected into the recipient as quickly as possible. Later it came to mean the application of various pumps for the rapid transference of blood from a donor, who virtually lay beside the recipient. This represented a great advance. The indirect method, which was first practised in 1914 upon the introduction of citrate as an anti-coagulant, implies the drawing of blood from a donor into an anti-coagulant solution and its subsequent injection into the patient, immediately, or in a few minutes, or after some short delay (from a few hours up to possibly forty-eight hours), or after a definite period of careful storage. The period of storage may be anything up to a fortnight.

In the reviewing of these procedures, with their application to the services particularly in mind, it was held that any form of direct transfusion might be difficult and fraught with disadvantages. It might mean that a man who was well and capable of doing full duty might be taken and used as a donor, and rendered at least technically unfit for full duty for some hours or a day or two. There was the precedent that in the last war a man who gave blood was allowed some compensating period of leave, whether he needed it or not. He probably expected it and psychologically it might be necessary. By the indirect method of blood transfusion it was thought that it would be easier to use the walking wounded—the man who was necessarily out of action, but who was still able and willing to assist by giving some blood, and whose period of inactivity was not increased by his doing so. For those reasons, and because blood taken by the indirect method might be transported some hundreds of miles between the taking and the giving, and because the taking might be done relatively at leisure, our minds turned strongly to the indirect method. We decided, therefore, that the first thing to provide for was indirect blood transfusion.

The second necessity was the administration of physiological solutions. The enormously wide application of such treatment in medicine and surgery calls for no comment. It appeared to us to be no less important than blood transfusion in the general medical treatment of an army.

[1] Part of a symposium held at the Royal Australasian College of Surgeons on April 17, 1942.

It has to be borne in mind that every sick man in the services is not a wounded man. He may have suffered from dysentery; he may have a chronic septic disorder; his condition may belong to any of a number of types calling for intensive fluid therapy, with or without infusion of blood. Our second problem, then, was adequate provision for physiological solutions.

Thirdly, we were all beginning to think and talk of the use of serum and plasma, but we did not know a great deal about how this new field was going to develop.

Our next step was to combine these three functions into one apparatus, if that were possible. We wanted to send forward something which would contain a supply of solutions; which, when empty, would constitute a transfusion apparatus—a transfusion apparatus such that it could be used for immediate or slightly delayed or remote transfusion. We sought also to incorporate in it certain features which would suit the use of serum or plasma, should they later come to have importance. We settled on the idea of a bottle, embodying well-known principles, and having a capacity rather exceeding a litre. The idea was that this bottle should accommodate all the blood that one would take from one donor at a sitting; alternatively, it would accommodate a reasonable amount of physiological solution or it would serve for the storage of a reasonable amount of blood. We associated with this bottle sets of accessory parts for taking and giving blood in the proportion of five giving sets to two taking sets for every ten bottles. The conception here was that the average patient who required transfusion of some solution would probably require more than one bottle full, and the solution could be left to drip quietly into the patient's vein, whereas the method of taking blood required the constant attention of a medical officer. Therefore, we considered that that ratio would fit into the working capacity of the surgeon on the job. This combination of ten bottles of solution, each a potential transfusion set, five giving sets and two taking sets, was built into the standard transfusion pannier. That was to be the unit of issue to the services, and has in fact been so. In the background, as accessories to them, there are renewals for all the expendable or fragile items, including further supplies of citrate, local anæsthetic agents and the like. The adoption of this unit committed us to the indirect method of transfusion, but otherwise we hoped it was as flexible as possible and could be adapted to such needs as might arise. It embodied provision for a variety of technical procedures, and it was suitable for transport, if this was necessary.

The apparatus has been put into use in all three services. You are about to hear some discussion which will largely hinge on whether we were right or wrong in choosing the indirect method on which to base our plans, and after that something of the facts showing whether or not the apparatus worked in actual practice. I can do no better service than to leave the remainder of the evening available for those talks.

TRANSFUSION BY DIRECT METHODS.[1]

By JULIAN SMITH,
Melbourne.

THE revival of the direct method of blood transfusion has been sufficiently long in operation in this city to warrant a progress report.

The Apparatus.

Over two years ago I returned to the study of this method because I imagined that it might become a worthy accessory to the existing deservedly well-established methods of resuscitation in war. The first objective was, therefore, a study of apparatus, and since by far the greatest number of direct transfusions were being given in the United States of America, first consideration was given to these. In nearly all cases one or other form of syringe was being employed. The Rudder valve syringe appealed to me most, and I went so far as to have made a stainless steel example, which I shall show you tonight. It was successfully used a few times, but difficulties arose about the supply of syringes of good quality in this country. Moreover, the use of syringes for the purpose had never attracted me. I therefore decided to exploit the rotary pump principle, first suggested by Noel in 1876 and used in 1936 by Henry for the design of a transfusion pump employed in France. Almost simultaneously with me, Dr. John McLean was also considering the rotary pump, and under his direction the first machine was made, the design being one illustrated by Victor Riddell in his book on transfusion. The basic principle of all of these pumps is the serial compression by a single roller of a loop of rubber tubing coiled inside an open metal cylinder. Need for improvement on McLean's early model was soon apparent, and the next type had a clamp added and an easier device for introduction of the tubing. The next change I made was to cut away the well wall in part so as to permit rapid and easy introduction of the tubing. Two rollers were then, of course, needed, and a plug-in revolution counter was added. Ultimately this counter was discarded in favour of one incorporated in the machine itself. This counter took the form of a graduated toothed ring revolving round the body and operated by a ratchet arm driven from the lower end of the main spindle. One revolution of this ring corresponds to ten ounces of blood put out by the pump, and its upper surface is graduated in ounces. The distance between the well wall and the two compression rollers is adjustable in order to provide for variations in the diameter of the pressure tubing should it occur. Throughout the work the tubing used has been the red ribbed rubber as used on stethoscopes. It is twenty inches long and is joined by glass unions to two pieces of collapsible number 10 drainage tube, which at the distal ends accommodate the donor and recipient needles.

The Technique.

The plan of operation of direct transfusion is as follows. The two persons concerned lie on adjacent tables, which are about twenty inches apart. Between these the operating bench is supported, and to this are clamped the pump, the saline solution pot and the time-recording stop-watch. A few ounces of sterile saline solution for intravenous use are poured into the pot and the sterile tubing system is introduced into the pump and the ends are placed in the saline solution. The revolution counter is set to zero and out of action. The air is displaced from the tubing by a few turns of the handle. Usually the recipient has a loosely wound narrow arm compressor connected to an air-bag on the floor. Foot pressure on this gives temporary compression and satisfactory display of the vein. Quite often a needle may be inserted into the recipient vein, but a sterile cutting-down set must always be on hand. Proof of vein entry is made by a gentle turning of the pump, which continues until the donor's needle is lifted for insertion into his vein. The donor now takes up his position and the tourniquet is applied. The pump is, of course, arrested for the moment, and as soon as the vein is entered the handle is steadily turned, the counter is put into action and the stop-watch is started. The assistant's eye is kept on the stop-watch and the counter, and the handle speed is so regulated as to transfuse one ounce in every fifteen seconds or thereabouts. Watch must also be kept on the fullness of the donor's forearm. Should it lessen noticeably, the pump speed is reduced somewhat. Moreover, if the tubing connected to his needle actually collapses, the speed must be greatly reduced until suitable grasping movements of his hand induce a better blood delivery. The usual result in a series of approximately three hundred transfusions has been that one pint of blood has been transfused in or about six minutes. As much as thirty ounces has occasionally been transfused in this time. When delivery has been

[1] Part of a symposium held at the Royal Australasian College of Surgeons on April 17, 1942.

slow, the transfusion time has been lengthened to as much as seven or even eight minutes. In these longer periods clot blockage of the tubing system may occur, and then the pump pressure automatically disconnects the tubing.

I should say here that I have seen no evidence of embolus at all in any case, and criticism which has been made of the technique as a source of this danger is apparently unwarranted.

It has also been said that direct transfusion is difficult as compared with the citrate method. The main difference between the two is the fact that the former is a set operation with everything assembled at the one time and place. Moreover, the entry of the recipient's vein comes first and is wasted unless the manipulation of the donor is successful. This is, of course, assured when cutting down on the donor's vein is permitted; but almost all of the work here has been by venipuncture, and if, as has occasionally been the case, the first attempt is faulty, another vein has been chosen. In no case of the series has there been complete failure, and in the vast majority of cases the amount transfused has been one pint or a few ounces over this. There is, therefore, the one tense moment—puncture of the donor's vein. Apart from the dexterity required for this, the rest of the undertaking is purely a matter of study and practice.

The proximity of donor and recipient has not been a difficulty. They need not see one another, and in favourable circumstances they are not together for much more than a quarter of an hour.

The speed of blood loss of the donor has not given trouble. The practised service donor is completely unaffected. The unpractised relative or friend has occasionally shown some temporary loss of colour and increase of pulse rate, usually of psychological origin.

I am not sure that I understand what is meant by the term "speed shock"; but I can say that in none of the cases has there been any evidence that the speed of transfusion (meaning by that term a pint or more of blood given within six minutes) has been in the least harmful. A reduction in pulse rate and an immediate improvement in colour always occur. Nervous recipients should have a mild preliminary sedative.

Transfusion Needles.

I should like to say a few words about transfusion needles. Granting that sharpness is axiomatic, I think that each worker at direct transfusion should use the needle familiar to himself. I have, for instance, used the Ian Wood needle with full satisfaction; but I have found the samples supplied rather large in diameter, being 2·4 millimetres or over. Now, so far as I can gather, very little thought is given by the makers to the inner wall of the needle, and it is to the burnishable anti-coagulant qualities of this surface that any needle owes its value. Obviously the outside diameter of the needle should be kept as small as possible, and therefore thin-walled tubing is desirable. I have spent much time in seeking for these qualities in the specimens of stainless steel tubing at my disposal, and I find that a thin-walled two-millimetre sample affords on the one hand a fairly sure entry to the vein and on the other hand a wide enough bore to avoid premature blockage. The internal surface of the tubing as it comes from the maker's mandrel varies from specimen to specimen; some specimens are deeply grooved, some are are uniformly dull and difficult to polish, and some are so smooth as to become mirror-like with very little burnishing. Therefore many specimens have been rejected forthwith. Good smooth-bore specimens with overthick walls have been reduced by grinding, preferably with some amount of taper towards the point.

Attention has been given also to design. Dr. McLean has evolved a needle cannula combination which has proved a useful tool. It gives a sure entry into the vein and also a reliable blood delivery. Naturally the outside diameter is larger than that of the simple needle types, and at present the successful specimens of thin wall and small diameter cannot be repeated in quantity owing to lack of suitable material. On the other hand, I have experimented with a single needle type, adopting the same base plate, but have brought the shank of the needle back through the base plate and female collar sufficiently far to reach, when in place, the rear end of a detachable nipple. This detachable nipple is inserted into the rubber tubing of the pump, so that its free end, as soon as the blood gush appears, slips over the rear end of the needle and engages in the base plate collar, thereby making an air-tight union during the transfusion.

Summarizing the needle question, I can say that a bright, smooth, stainless steel needle should have a bore of not less than 1·4 millimetre to be universally successful. There is a small supply of 1·8 millimetre tubing giving this bore, but most of the needles have to be made from two millimetre bright interior or from 2·2 millimetre tapered tubing, and the bore measurements range from 1·4 millimetre to 1·6 millimetre. I prefer to reserve 2·4 millimetre needles for the easy veins, and the bore of some of the specimens I have is as high as 1·85 millimetres. The question of bore diameter and brightness is certainly linked with that of clotting time of the donor. When the needle is examined immediately after transfusion, the amount of fibrin deposit will be found to vary very much from case to case. In some cases practically none will occur; in others so much will occur as nearly to obstruct the lumen. I have, in a number of cases in which premature blocking threatened or occurred, tested the clotting time, using capillary tubes of similar bore and my own blood as a control, and found the donor clotting time abnormally short.

The Justification for Transfusion by the Direct Method.

I shall now discuss shortly the justification for direct transfusion by the direct method. Intelligent patients who have been given both unmodified blood and citrated blood have frequently said they prefer the former. To use their own words, "they feel fresher, or lighter, or as if a cloud were lifted". If this is really so, it may be because the rapidity of the transfusion produces an easily observable improvement.

Then again, there can be no question about the nursing staff's preference for direct transfusion, because it is a set operation and is over and done with, whilst the lengthy attention necessary in drip methods is more exacting, as well as being distinctly trying to many patients. I have already hinted that, in certain circumstances, direct transfusion may be the only easily possible method available; and when it is seen that everything required, including the operating bench, can be carried ready for use in this small case, further justification may be admitted.

But these are small matters. On the other hand, when one turns to clinical evidence, it is found that there is a general agreement about the superiority of unmodified blood for transfusion in the anæmias, in the purpuric group of cases and in hæmophilia. I consider that the technique here given has placed in the hands of the hæmatologist a reliable and essential instrument.

Another group of cases deserving attention includes the infections in which anæmia is not the whole problem. One may mention ulcerative colitis as an example. But those of this group that concern us more tonight are the surgical cases associated with delayed recovery, and indolent wounds. Citrated blood most certainly does help such patients; but I have gained a strong impression when using direct transfusion in such cases, for instance, prostatectomy, that the cleaning up of the wound, the rapid healing and the general bodily improvement, cleaning of the tongue and so forth, came more quickly and surely than was expected. Moreover, I suggest that wounds associated with chronic sepsis also present a promising field for similar trial. I am aware that impressions may be untrustworthy, and that belief can be truly based only on an extended series of parallel cases or on laboratory inquiry. If we use the known facts about the changes in stored blood and the admitted diminution of antibody titre, observable within twenty-four hours, and consider that the tests are not delicate enough to detect smaller amounts than, say, 20% to 40%, we may

quite fairly ask when these changes begin. May it not be assumed that they begin at once and that they have proceeded to an appreciable amount within the time usually occupied by a drip transfusion? Moreover, the rapid deterioration of the leucocytes so as to make phagocytic tests impossible must be borne in mind, as well as the immediate disintegration of the thrombocytes. This inquiry might be carried nearer to truth and certainty by the employment of a series of patients with anæmia, each requiring multiple transfusions, giving them alternately citrated blood and unmodified blood. Investigation of clotting time and bactericidal power could be made before and after all the transfusions, and elucidation might follow.

Passing from these more or less theoretical considerations, we come to something nearer to fact when hæmorrhage is treated by direct transfusion. The massive treatment by citrated blood in grave cases of hæmatemesis due to ulcer is today an accepted practice. A few such patients, however, require very numerous transfusions indeed, and even then they may not survive. It occurred to Dr. McLean, when he was asked to examine such a patient, who was doing badly after being given several pints of citrated blood, that direct transfusion might be more rational. He has recounted in a recent paper of his[1] the very satisfactory sequence of events that led to complete recovery after direct transfusion in this first case. Since then he has treated about twenty patients by direct transfusion alone or following transfusion of citrated blood; in four of these cases citrated blood in massive quantity was not succeeding, and direct transfusion was promptly followed by cessation of bleeding and by good recovery.

In my own demonstrations of the use of the pump at public hospitals and elsewhere I have encountered, amongst many other affections necessitating transfusion, ten cases of grave hæmorrhage due to ulcer. Only one of these patients was in that serious condition of not doing well after receiving five pints of citrated blood, and promptly and permanently improved up to full recovery after being given one pint of unmodified blood. Two others were *in extremis*; to one I gave a total of 54 ounces in two days; the other had received saline solution intravenously and also citrated blood, and I followed this by twenty-five ounces of direct blood. He promptly improved; but moderate hæmorrhage began again three days later, and he was immediately given another direct transfusion of twenty-five ounces of blood. Thereafter he did quite well.

I have encountered also one very grave case of rectal hæmorrhage following an injection for hæmorrhoids. The patient was unconscious and had a hæmoglobin value of under 30%. Dr. McLean and I gave him a total of 75 ounces of blood by direct transfusion within three days. He regained consciousness and emptied his colon of a large amount of stale dark clot. This was accompanied by the loss of a small amount of bright blood at the beginning, but no more of this was seen. Within ten days he was converted from a dying man into a convalescent with a hæmoglobin value of 70%.

Discussion.

Now the total number of our combined cases of hæmatemesis is thus quite small, and an extension of the series might easily display no great advantage of direct transfusion over the citrate method. The physicians attending these patients have uniformly expressed a preference for blood given by direct transfusion as a hæmostat, and, moreover, incline to the view that recovery and discharge from hospital have been distinctly more rapid than their experiences with transfusion of citrated blood had led them to expect. My own view is that the onus of proof rests upon those who deny a preference for unmodified blood in these conditions. I consider that ideally all patients needing transfusion on account of hæmorrhage which is recurrent or likely to become recurrent should be given unmodified blood. If the emergency is great, it would be preferable to give an adequate amount of serum with the pump and then as soon as possible to follow this with blood by direct transfusion.

[1] The Medical Journal of Australia, September 13, 1941, page 281.

It is not to the point to discuss here and now the pros and cons of the surgery of hæmorrhaging peptic ulcer, except to say that a decision for action must be made within a day, or at most two, in order to avoid a prolonged exsanguinated state of the tissues. During this period transfusion of blood in large quantities will be necessary and may relieve the situation. But if it does not, and if operation becomes imperative, it would seem that the preliminary transfusions should be given by the direct method. For, though the assertion that a large amount of citrate does little harm to the recipient because it is soon eliminated may be true of a vigorous, normal person with the full amount of blood and body fluids, it may not by any means apply to an exsanguinated, weakened individual, whose tissues and remaining blood are much less able to withstand the osmotic affront of a short-period intravenous dosage containing as much as from 20 to 30 grammes of the sodium citrate salt.

Conclusion.

In conclusion I want to give prominence to the complete absence of transfusion reactions in the series of 300 cases treated. We have, as a routine measure, directly matched the donor's corpuscles with the recipient's serum; in many cases reverse matching has also been carried out. Fortunately, so far, none of the rarer types of reaction, such as those due to a recent pregnancy or to the Rh factor, has been met.

TRANSFUSION USING INDIRECT METHODS.[1]

By Cyril Fortune,
Perth.

The subject assigned to me in this symposium is an important one, and for the present purpose may be limited to a discussion of the administration of fluids to soldiers and civilians burned, crushed or lacerated in war. It is also a difficult subject because of the continual change of ideas respecting the usefulness of blood and its products, with its additional problem of establishing in some exact and speedy way a quantitative analysis of varying plasma protein and crystalloid values in the circulating fluid of the body as seen in pathological states.

Great progress in the study of transfusion therapy has in a large measure been due to three factors: first, the development of the citrated method of transfusion, with very simple apparatus; secondly, the reduction in frequency of reactions due to careful cross-matching, and careful cleansing of apparatus; and thirdly, the use of stored blood, plasma and serum.[1] No longer do we think, when a patient needs blood, that we will give just one pint.

At this meeting, with its emphasis on the use of blood and blood products, one can omit the more complicated problem of crystalloid balance and confine one's attention to the following four aspects of transfusion therapy:

1. The physiology of plasma protein relative to normal and failing circulation seen in (*a*) traumatic shock, (*b*) hæmorrhage, (*c*) burns, (*d*) hypoproteinæmia.
2. Clinical and laboratory methods adopted in the establishment of a quantitative measure for the use of blood and blood substitutes.
3. The apparatus used for giving these fluids by indirect methods.
4. Application of this knowledge in the development of sound methods in both army and civilian emergency services in the present war.

The normal physiology of plasma protein and fluid interchange must be appreciated by the surgeon and physician before they can understand pathological changes.[10] Normally there is a free interchange of water and crystalloids between the intravascular and extravascular compartments, but the protein molecule is of such a size that it is normally held within the vascular lumen and prevented from passing out into the intercellular spaces, and thus it exerts the important function of maintaining osmotic tension in the capillary bed.

[1] Part of a symposium held at the Royal Australasian College of Surgeons on April 17, 1942.

Only a certain proportion of the capillaries function at one time, capillary activity being initiated by accumulation of metabolites and parallel degrees of lowered oxygen tension. Given an adequate concentration of protein in the plasma, a normal fluid balance is largely determined by the proper ratio existing between the potassium within the cell body and the sodium ion in the extracellular fluid.

Let us now apply these principles to altered physiological states.

It is being more and more recognized that the primary purpose of parenteral administration of fluids to the wounded patient is to interrupt the establishment of a vicious circle consisting of the loss of fluid and protein from the intravascular compartment, with its consequent concentration of solid elements of the blood and with its interference with the efficiency of the oxygen-carrying apparatus. This results in widespread damage to capillary wall endothelium and in further fluid loss and decreased blood volume. Continuation of this process for more than a short period of time results in the establishment of the clinical picture of shock, with consequent increase in the gravity of any patient's condition.

In the face of hæmoconcentration dilution is necessary. This is best accomplished by plasma or serum, rather than by easily diffusible crystalloid or whole blood, with its less efficient diluting ratio. Therefore, the prompt, rapid and adequate transfusion of serum or plasma is the therapy specifically suited to this type of shock. If the treatment is inadequate, or if transfusion begins after the irreversible phase, then the patient will die.

In the presence of hæmorrhage with moderate blood loss, peripheral arteriolar constriction will compensate for decreased blood volume and specific treatment may not be necessary. With continued hæmorrhage and progressive decrease in blood volume beyond approximately 30% of the total, arteriolar constriction is not sufficient; the blood pressure will continue to fall and capillary stasis will ensue, followed by cell anoxia and finally death.

As the peripheral failure is due to hæmorrhage, the ideal treatment is the replacement of the blood lost by a sufficient quantity of perfectly compatible blood. But, as the main problem is the restoration of blood volume rather than of red cells alone, I agree with Blalock[13] and others that serum or plasma may be efficiently substituted.

The war-time advantages of serum or plasma as contrasted with whole blood are the following.

1. It is easy to carry to forward units, especially the dry product, which keeps indefinitely and at any temperature.

2. It is a pooled product, which can be administered in a crowded dressing station without fear of reaction or without the inevitable loss of time usually associated with the administration of whole blood.

3. As a temporary measure it restores sufficient blood volume to prevent the development of shock during the period that must necessarily elapse before the patient can reach a casualty hospital where he can be completely investigated and treated. In other words, it prevents the development of shock or its progression in a patient during the calculated evacuation time of four to six hours, and allows him to be brought to a casualty hospital in an operable condition.

The disturbed physiological picture seen in extensive burns is much the same as that seen in traumatic shock, with an added loss of plasma protein into the burned surfaces and the tissues beneath them. Here experience has shown that one must anticipate shock and promptly administer colloid in the form of plasma or serum, which must be given in enormous quantities, to be varied with blood if hæmoconcentration changes to hæmodilution.

The early administration of cortical extract is of proven value.

Hypoproteinæmia is seen in fevers, in starvation and following operative measures in which loss of fluid has been excessive. It is accentuated when isotonic solutions given intravenously have still further washed out protein. Traumatic and surgical shock is more easily induced and wound healing is inhibited in the state of decreased plasma protein concentration. If the gastro-intestinal functions are intact, an adequate intake of protein is sufficient; but if this method fails, the parenteral administration of blood plasma or of serum will restore to normal the protein content of the blood.

Let us consider the methods we have at hand for the assessment of the need for transfusion, remembering that, according to the nature and severity of the injury, one of two physiological variations (hæmoconcentration or hæmodilution) may be present.

Vaughan has shown that of 1,500 air raid casualties 8% to 15% needed transfusion, and the average amount of serum transfused was 1,000 to 2,500 cubic centimetres.

Grant and Reeve[1] issued an official report to the Medical Research Council of the Privy Council in August, 1941, giving a studied analysis of 100 cases; 83 had transfusions, 50 of them receiving both blood and plasma. The average amount given was just over 1,200 cubic centimetres of fluid; but for the severely shocked patients requiring intensive resuscitation, 2,000 cubic centimetres of fluid were required, usually as an initial transfusion of 1,500 cubic centimetres of serum followed by 500 cubic centimetres of blood.

Some hold that the amount of protein given by the transfusion should be not less than 50% of that contained in the fluid lost, and that transfusion must continue during any delay before operation as well as during operation.

Edwards,[2] of Liverpool, has a belief that in many cases serum has not been used in large enough quantities, and further, that sometimes forced pressure is needed with the use of more than one cannula.

Grant's criteria[3] for the assessment of fluid loss were based mainly on serial estimations of pulse rate, blood pressure, skin colour, temperature and hæmoglobin value. These observations were made every fifteen minutes from the outset.

The pulse rate has proved unreliable as an index of progression or recovery.

Hæmoglobin values do not give a true index of the severity of the condition.[15] Great stress has been laid on serial estimations of blood pressure, and in resuscitation wards manometer cuffs are left on the patient's arms and the staff is trained in the taking of blood pressures. Cope[4] agrees that these readings are at present the most reliable guides, but by no means perfect. Why? Because a noted degree of shock may exist before the systolic blood pressure falls, and when it falls it may mean that an irreversible condition has supervened.

Cronin[5] is emphatic:

> The fall of blood volume in severe shock, accompanied by hæmoconcentration, precedes sometimes by hours the fall of blood pressure. The latter is a comparatively late effect and the blood pressure may still be high when the state of shock is well nigh irreversible.

Whitby[6] and others, in their reports on traumatic shock, stress the value of hæmatocrit readings and of accurate cell counts and estimations of hæmoglobin value. I agree.

The lessons to be learned from these findings are that we must assess the severity of the injury and the probable blood loss, rather than be guided solely by the blood pressure, which nevertheless must be estimated.

When the blood loss has been assessed in the presence of altered blood values, an immediate effort must be made to restore decreased blood volume and lost blood protein. This effort should be in the form of a rapid infusion of blood products to meet the physiological need both quantitatively and qualitatively. After two to three pints of serum and blood have been given, if the blood pressure remains below 100 millimetres of mercury, clinical observation has shown that the chances of recovery are slender.

Providing that no further hæmorrhage occurs, the administration of 500 cubic centimetres of blood or serum is followed by a rise in the systolic blood pressure of approximately 10 to 20 millimetres of mercury.

The failures are usually those cases in which continual bleeding is present or in which a sufficient quantity of blood products has not been given.

We must be prepared to meet such a case as that quoted by Wilson,[7] in which a man received in all over five litres of blood and plasma in twenty-six hours.

It is curious that British workers should make very little reference to the work of Scudder[8] and others, who have stressed the value of blood studies as a guide to therapy in shock. Two indispensable aids to the surgeon dealing with shocked or potentially shocked patients are the hæmatocrit tube and a modification of the specific gravity measuring apparatus of Barbour and Hamilton.[9] Blood collected from a patient can be centrifuged in a hæmatocrit tube and an accurate estimation of total cell volume obtained. From the supernatant plasma, with the use of the "falling drop" apparatus, an estimation of the total plasma protein content can be made swiftly and accurately in fifteen minutes by any person with the slightest degree of training. At the same time a quarter-hourly check can be made on the specific gravity of the patient's whole blood by the substitution of whole blood for plasma.

Rising hæmatocrit values and an increasing specific gravity of blood are an absolute indication of hæmoconcentration and an indication for the administration of serum; at the same time a patient exhibiting hæmoconcentration is quite likely to be losing protein, and therefore his plasma may have a decreasing specific gravity. On the other hand, a decreasing hæmatocrit reading will indicate that hæmorrhage is continuing and that it is the principal factor in the patient's failing condition. In this way patients can be easily and satisfactorily watched and shock can be prevented.

Therefore it is obvious that careful and adequate checks of hæmoconcentration must be made to prevent and control shock in surgical patients. This can be accomplished only in the laboratory. With the advent of the hæmatocrit "falling drop" apparatus, the long-felt need for a quick, easy, and at the same time accurate, method has been satisfied. One can determine, from a therapeutic point of view, whether blood, serum or salt is needed, having first obtained a fairly clear idea of the history and clinical picture of the patient before a final evaluation is made.

Methods of Transfusion.

What methods can we use in giving blood and its products to the patient in need?

Indirect methods of transfusion are now universal.

Hustin, of Belgium, and Lewisohn,[6] of New York, in 1914 proposed a method of collecting blood in a vessel containing a percentage of citrate and glucose.

Rous and Turner[7] in 1916 showed that it was possible to preserve blood, and this method was adopted by Robertson in France in 1917.

The use of placental blood for massive transfusion was reported from Moscow and is still tried in a few small centres.

Yudin, impressed by Shamov's experimental work on dogs, used cadavers in the Emergency Hospital of Moscow; here the first blood bank was formed.

Great strides were made during the period of the Spanish civil war by the workers at Barcelona, who proved undoubtedly the value of donors' organizations as a source for human blood. They also simplified the methods of storing blood in ampoules, and it will be seen that the Germans are now using a similar type of apparatus to that used in Spain.

In 1937 Fantus set up his blood bank at Cook County Hospital in Chicago, the forerunner of many such institutions throughout the world. Because of the world-wide use of preserved blood and its products, and of the equipment under the stimulus of war, the equipment for the collection and delivery of blood has been the subject of a tremendous amount of recent analysis, criticism and change.

The gravity method by bottle and tube is the one of choice, because it can be standardized for institutions. It is inexpensive; its method is easily taught; the bottle can be used for storage and transport, and the set is common for the use of crystalloid, serum and blood.

The English workers, just prior to the war, met in conference, merged most of their individual ideas and evolved a compact apparatus, which fulfils all the criteria necessary for ideal technique in war-time. I believe the English military transfusion outfit, with its bottle and giving set attached, is the simplest of its kind in the world. The main features are its handy size, with a minimum air space above the blood, an easily perforated bung, a filter and drip; it is simple in design and easily cleaned. It is suitable for storage of blood and of dry serum.

The "Soluvac" apparatus must come in for its share of criticism as a standard unit. Its screw cap top with five separate parts and perforator are far too complicated. Any glass air tube in a storage bottle tends to form clots. Both Vaughan and the Spanish workers confirmed this fact. The size of the receptacle should be such that the blood completely fills it.

Scudder showed that if there was a large air space above the blood level hæmolysis of the red cells occurred, with consequent higher potassium values.

It is accepted in most transfusion centres that a 500 cubic centimetre contribution of blood is a reasonable donation, and therefore a bottle with a total capacity of 600 cubic centimetres is sufficient in size.

It is necessary to filter stored blood, serum or plasma. A metal filter is satisfactory, whether incorporated in the bottle or in the giving set. A cotton or gas-mantle filter is much cheaper.

Operative accidents can be reduced to a minimum by the employment of well-designed equipment and by the avoidance of cutting down on veins — a procedure rarely necessary. This last point must be emphasized. In Spain, cutting down on patients' veins was necessary in only 10% of cases. In my own practice, unless the patient is in need of therapy for a long time, I invariably use a sixteen or eighteen gauge needle for giving fluids. De Gowin[10] has shown clearly that it is unnecessary to warm blood or serum.

The complications of blood transfusion have been clearly defined and may be avoided if certain facts are borne in mind. Circulatory failure can be prevented by the evaluation of a patient's cardiac reserve and by the avoidance of rigors, which are usually due to poorly prepared apparatus and solutions. Such rigors are not of benefit to the patient, but rather do harm.

Chronically anæmic subjects may be given transfusions at a "drip" rate, and if a large amount of the transfused fluid is required it is often wise to divide the operation into two parts, each step separated by a day or two. "Drip" transfusions decrease overloading of the circulation, lessen chills and rigors, and give more time for the interaction of the patient's corpuscles and the incoming serum.

The reactions due to incompatible blood are of a serious nature, and the importance of cross-matching blood samples before every transfusion must be emphasized. Donors who are suffering from syphilis, malaria or influenza should not be used.

No details will be given concerning those cases in which the patient's blood and the donor's serum are compatible when tested *in vitro*, and yet when a transfusion is given there is a severe hæmolytic reaction. It is a problem yet to be solved.

Transfusion Services.

We have profited by the suggestion of Sarrat, Giaccardy and Thillard,[11] three French surgeons, who maintained that an autonomous service for blood transfusion work should be set up as a branch of the Army Medical Corps, in order to carry out the task of storing blood for not longer than two weeks, such blood to be prepared outside the zone of military operations, but with an organization flexible enough to be sent forward to the proper place at the proper time. Such a conception was carried out splendidly by the Republican authorities in Spain, who were able to provide blood for the requirements of an army by use of their sealed ampoule.

In Russia the workers are keen in the use of stored blood and serum. They are experimenting with ascitic fluid. They are enthusiastic about large transfusions in the treatment of shock.

It is difficult to ascertain what the Germans are doing, but we do know that they use an ampoule type of apparatus

for giving blood. As blood substitutes they have been using a crystalloid called *Tutofusion* and a colloid called *Periston*, the nature of which are unknown. They store Group O (4) blood in blood stations behind the front lines.

Here in Australia we are progressing along similar lines; but I believe we must go further.

It seems an opportune time to lay stress on the fact that any programme concerning transfusion therapy should include emphasis on the establishment, maintenance and improvement of well-equipped army transfusion centres in various parts of this country, such centres to develop efficient and less expensive means of preparing dried serum and of confirming the question of maintaining liquid serum. These centres would act as bases for sending supplies of preserved blood and serum forward to hospitals and casualty clearing stations.

At these centres courses of training could be given to resuscitation teams and laboratory technicians, so that orderlies in forward units and trained sisters in hospitals would become proficient in the preparation of transfusion equipment and in assisting at transfusions and at times even in giving them.

Plasma infusion teams with attached hæmatologists are an entity in the framework of the emergency services of Leeds General Hospital.

For our civilian community Red Cross blood transfusion centres have been set up in each State for the taking of blood from donors, for the manufacture of serum and for use in a civilian emergency. Numerous teams at civilian emergency hospitals are being trained as resuscitation units, capable of treating shock and of understanding transfusion technique. In England, in both civil and army practice, organized transfusion services have proved to be of inestimable value.

Conclusion.

There is now every encouragement to hope for a big and permanent improvement in the treatment of conditions involving loss of fluid by the circulatory system. With our knowledge of blood and its products much clinical and chemical work still remains to be done. It is necessary for personnel to have a clear conception of the problem of controlled fluid therapy, to understand the few simple tests required for judging the state of hydration in the capillary and venous circulatory systems, and to be given the opportunity of working with simple, efficient apparatus. Such a development will come by the establishment of well-equipped transfusion centres in both army and civilian organizations, controlled by a far-seeing medical research directorate.

Acknowledgements.

I should like to express thanks to Brigadier D. M. McWhae, C.M.G., C.B.E., Deputy Director of Medical Services, Western Command, for permission to present this paper, and to Lieutenant-Colonel A. Vickers for his encouragement. I am indebted to Captain F. McD. Richardson, United States Army Medical Corps, for his helpful criticism.

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SOME OBSERVATIONS ON TRANSFUSION IN THE MIDDLE EAST.[1]

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During the past two years it has been my privilege to take part in transfusion work in the Middle East with two different units, an advanced surgical team under Major (now Lieutenant-Colonel) Julian Smith, and an Australian general hospital under the guidance of Lieutenant-Colonel L. C. Lindon, Officer Commanding the Surgical Division.

Transfusion with a Surgical Team Working at an Advanced Australian Imperial Force Dressing Station during the Battle of Tobruk.

Special Equipment of Transfusion Unit.

The equipment included a number of transfusion panniers (Australian military pattern), two standard ice chests for blood storage presented by the Australian Red Cross Society, filled with one hundredweight of ice, six racks to hold transfusion bottles and extra supplies of glucose saline solution and sodium citrate solution. The equipment contained in the transfusion and infusion panniers was used solely throughout, and it proved to be most satisfactory.

Medical Arrangements at Tobruk.

On January 17, 1941, a thirty-hundredweight truck left Alexandria for the Tobruk perimeter with one officer, one driver and two orderlies specially trained in transfusion work. The journey to Tobruk was uneventful. The first night was spent at the casualty clearing station at Mersa Matruh and the second in the desert between Bardia and Tobruk. The Tobruk perimeter was reached on January 19, and the team reported to the late Lieutenant-Colonel A. J. Cunningham, commanding officer of an Australian field ambulance. The team worked in the main dressing station of this ambulance.

The arrangements at this main dressing station, situated five miles from the Italian lines at Tobruk, have been described in detail by Julian Smith.(1) The main dressing station was staffed by two Australian Imperial Force field ambulances, and throughout the battle the two ambulance commanders, Lieutenant-Colonel Cunningham and Lieutenant-Colonel L. E. Le Souef, and their personnel rendered most valuable assistance to the resuscitation team.

It was through this main dressing station that the majority of the casualties were evacuated, especially in the earlier part of the first day (January 21). From the main dressing station the wounded were evacuated to a British casualty clearing station at Bardia, which was reached over fifteen miles of rough desert road and then fifty miles of bitumen road (Tobruk to Bardia), which

[1] Part of a symposium held at the Royal Australasian College of Surgeons on April 17, 1942.

had been severely damaged by aerial bombing. The journey occupied about eight hours. Two Australian Imperial Force advanced surgical teams assisted with the surgical work at this unit under Major (now Lieutenant-Colonel) E. S. J. King and Major (now Lieutenant-Colonel) K. Ross.

Personnel of Surgical Team at Main Dressing Station.—At the main dressing station the personnel of the operating team consisted of two officers and two orderlies. The personnel of the resuscitation team consisted of one officer and two orderlies. There were five nursing orderlies, supplied by the Field Ambulance. For forty-six hours the team was working continuously.

Tentage of Resuscitation Ward.—One large tent (Italian), 24 feet by 18 feet in area, and capable of holding 16 patients, was used. This was in direct communication with the annexe of the operating theatre (tented, Italian). In addition, there were two holding tents at a distance of about 20 yards, each capable of accommodating 10 patients. It was essential for the resuscitation tent to be in direct communication with the operating tent.

Procedure at Main Dressing Station.—The wounded were first examined by a medical officer at the reception tent, and if they required resuscitation or operation by the surgical team, they were transferred to the resuscitation tent. There they were examined by the officer in charge of resuscitation, and later by a member of the surgical team when he was not engaged in the operating theatre. The activities of the unit during the Battle of Tobruk may be summarized as follows:

Number admitted to main dressing station, approximately	200
Number admitted to resuscitation ward ..	40
Number in resuscitation ward requiring operation (3 deaths)	30
Number in resuscitation ward requiring blood transfusion (6 deaths)	14
Percentage of total casualties requiring blood transfusion	7
Average amount of blood given per patient	2·3 pints

Blood Donors.

Volume of Blood Collected.—Approximately 46 pints of blood were collected from 51 donors, an average yield of 18 ounces per donor. Major I. M. Mackerras collected 25 pints of blood from 28 donors, although it was the first time that he had used the apparatus.

Availability of Donors.—Volunteers for giving blood were easily obtainable among the walking wounded. They provided 35 donors in all. The remainder of the blood was given by 16 members of the two field ambulances, who pleaded to be allowed to give their blood when they saw the good results that were being obtained by transfusion. All these orderlies returned to duty immediately—they refused to rest. All the walking wounded walked back to the reception tent, a distance of 50 yards, within fifteen minutes of having given their blood. Actually, most of them were able to leave the stretchers and walk out immediately their wounds were dressed. There was only one instance in which the donor complained of feeling faint. This donor should not have been selected, as on subsequent inquiry it was found that he had already lost a considerable quantity of blood from a gunshot wound of his hand. However, he gave his full pint of blood and walked back to the evacuation tent.

Blood Grouping.

All donors and recipients in the Australian Imperial Force knew their blood groups, and this was always confirmed by inspection of their identity disks or pay books or both. Group O (4) blood was given to any of the British wounded whose blood had not been typed. No cross-typing was carried out. No agglutination reactions were observed. Two recipients had slight chills, which would be due to pyrogenic substances introduced in the water during cleaning of the equipment. These minor reactions occurred on the second day, when the equipment had been cleaned and reautoclaved many times.

The only occasion when blood grouping tests were carried out was in the case of an Italian prisoner of war, who received blood from two fellow prisoners who volunteered to help their comrade. There were many other volunteers amongst the prisoners; they were extremely grateful to learn that a transfusion was being given.

The history of this Italian is as follows:

On January 21, 1941, he was observed to be carrying to cover a wounded Australian who was lying in an exposed position in the battlefield. Unfortunately, when his object was nearly achieved, the Italian received a severe shrapnel wound of the leg. He was admitted to the resuscitation tent, where he was found to be very pale and his pulse was weak. Two and a half pints of blood were skilfully collected by a trained orderly in the blood transfusion team under the supervision of an officer. This orderly subsequently administered the blood, with great benefit to the patient. Later Captain D. Stephens amputated the leg. The patient's subsequent progress was satisfactory.

Blood Grouping of all Australian Imperial Force Personnel.—The typing of the blood of all Australian Imperial Force personnel has proved to be of the utmost value and has already contributed greatly to the efficiency of the blood transfusion service, and thereby has been instrumental in saving a number of lives.

Collection of Blood.

The collection of blood was commenced before the attack was launched and was continued while the wounded were arriving at the main dressing station. When giving blood, the donor lay on a stretcher and the needle was thrust proximally into the vein. Iodine was used as an antiseptic.

Snicking of the skin over the vein through a weal of anæsthesia was practised when the veins were not prominent, when big needles were used, or towards the end of the second day, when the needles were becoming less sharp. However, most of the taking of blood was carried out without local anæsthesia and without cutting of the skin. For each pint of blood 50 cubic centimetres of sodium citrate solution (4%) with glucose (1%) were used as an anticoagulant. This proved to be adequate, as no clots were encountered.

On the recommendation of Major Mackerras, two pints of blood of the same group were collected from two donors into each transfusion bottle ("Soluvac"). This proved to be a great saving of time and equipment, and enabled large volumes of blood to be administered without the necessity of keeping a constant watch on the bottles. The average amount of blood given to each recipient was 2·3 pints.

Early on the first day fresh bottles containing glucose (5%) in normal saline solution were half emptied of their contents and then completely filled with a pint of blood. This proved to be a satisfactory mixture.

Storage of Blood.

Two ice-chests donated by the Australian Red Cross Society were taken to the main dressing station in the thirty-hundredweight truck. At Alexandria both ice-chests were filled with ice. At the end of eight days a considerable amount of ice was present in both chests. This was all transferred to one chest, which was taken to the town of Tobruk, where it acted as a blood store during the early phase of the attack on Derna. In all, the ice lasted eleven days, and over 50 pints of blood were stored for a period of from one to five days. Owing to the constant demand for blood there was no opportunity to observe the maximum time for which the blood would keep. It would appear to be unwise to store blood for longer than two days when it is collected under these rather crude desert conditions. It would be preferable to use it within twenty-four hours of collection, as strict asepsis cannot be maintained.

At Tobruk and other seaports ice could be obtained from the ships in port. During the attack on Derna ice was sent forward to the main dressing station in the Derna area from Tobruk. A mobile ice-making plant and an ice delivery van, such as are being supplied by the Australian Red Cross Society, will be of great value.

The Giving of Blood and Other Fluids.

Blood was given by the standard technique, and no difficulties were encountered. The filter worked admirably. Often it was possible to insert the needle directly into the vein, but usually it was found that it was preferable to expose the vein and introduce a glass cannula. Usually this procedure occupied five or ten minutes, and the result was more reliable, especially when large volumes of blood were being given and when it was necessary to transfer the patient to the operating theatre. The cannula or needle was attached to the limb by strapping. If the arm vein was used, the wrist was tethered to the stretcher by a length of bandage passed around the stretcher pole after a small hole had been cut in the canvas. When possible, a vein one or two inches below the bend of the elbow was selected, and this permitted the elbow to be flexed slightly without occlusion of the vein. An arm splint (Cramer wire) was occasionally used when the patient was restless or when he had to be taken to the operating theatre or under both conditions.

Some medical officers preferred to use the ankle vein as the site to insert the cannula, as this avoided the use of splints. The foot was tethered to the end of the stretcher by means of a length of bandage, which was attached to the great toe by adhesive plaster.

Rate of Giving Blood.—To patients moribund from blood loss the blood was given at the rate of one pint in fifteen minutes, or even faster, but usually it took from half to one hour. When there was evidence of internal (uncontrollable) hæmorrhage this rate was usually reduced.

The Volume of Blood Given.—The volume of blood given to each patient varied with the history, the clinical appearance of the patient and the physical signs. A limited number of hæmoglobin estimations were made, but these proved to be of limited value. One man with several pints of blood in the peritoneal cavity had a hæmoglobin value of 100%. During the state of shock and dehydration the blood volume was not reestablished. The general appearance of the patient, the state of the peripheral circulation, the pulse rate and volume, and, if possible, the blood pressure, combined with the history and any evidence of external or internal bleeding, led to the decision to give blood. Lieutenant-Colonel Smith has stressed the demand for resuscitation in the forward areas; surgical treatment can usually be carried out later, and further from the front lines.

Serum.—Most of the patients were suffering from penetrating wounds and not from the effect of blast or burns. Thus it was almost universal to find that any peripheral circulatory failure was associated with blood loss. Blood was therefore considered to be of greater value than serum. It is certain, however, that at least two patients would have benefited from the administration of serum. They were suffering from blast injuries. Peripheral failure was present. The hæmoglobin value was between 110% and 120% (Sahli). Unfortunately serum was not available to this unit owing to enemy action. At some of the other units serum was administered to a number of patients and the results were good. It would appear that serum will prove to be of the greatest value at both main dressing stations and advanced dressing stations, where adequate supplies of blood may not be available. Experience has shown that at least one litre of serum will be necessary for each patient; sometimes two or more will be required. Should the wet serum be found to keep even under adverse conditions of temperature, then this fluid will be preferable to the dried serum, as it is ready to administer. However, until the keeping properties of wet serum have been fully investigated, it is essential to have dried serum available in addition to wet serum.

Glucose and Saline Solution.—Glucose and saline solution was given to several patients after they had received blood, especially if a severe operation had been performed. This proved to be of the greatest value in abdominal lesions. Later, if paralytic ileus developed, the transfusion of glucose and saline solution was a life-saving procedure. This was well illustrated in the case of Private H. described above. He received in four days 20 pints of 5% glucose in normal saline solution. For the first four days it was necessary to carry out repeated gastric aspirations by an indwelling stomach tube passed through the nose. The tube, which was made by Captain D. Stephens, consisted of a length of fine rubber tubing with a fine lead bullet to weight the end, and had four lateral holes punched in the distal six inches. On the fifth day the patient ceased vomiting and began to have normal bowel actions. He eventually recovered.

Additions to the Transfusion Fluid.—"Coramine" added to the blood or glucose and saline solution (one to three ampoules, each containing 1·7 cubic centimetres, per litre of blood or solution) had a beneficial effect on the circulation, especially when there was evidence of an associated respiratory failure. On occasions "Coramine" was given in higher concentration by slow injection through the wall of the delivery tube by means of a hypodermic syringe. Adrenaline was given in high dilution to two moribund patients who had extensive abdominal wounds. Fifteen minims of adrenaline (1 in 1,000) were added to one litre of glucose and saline solution and given in combination with "Coramine". The rate of flow was 60 drops per minute. The effect was encouraging, the patients' blood pressure rising within five minutes and the colour and degree of consciousness both improving. No ill effects were observed. Both patients eventually died; but it appeared that these drugs prolonged life for several hours. Neither "Neo-synephrin" nor "Veritol" was available; but either would have been of great value, and preferable, as they do not produce the dangerous effects of adrenaline.

Sulphanilamide.—Sulphanilamide was not given intravenously; but this would have been advisable in a number of the cases, especially those of abdominal wounds, in which it was not possible to give the drug by mouth. Every endeavour was made to give all the wounded in the resuscitation ward sulphanilamide by mouth, two tablets every two hours. During the busy hours the orderlies frequently omitted to give the tablets. It was then found helpful to employ an alarm clock in the ward set to go off at intervals of two hours. One orderly was detailed to issue the tablets together with hot carbohydrate drinks to all patients whenever the alarm sounded. However, recent work by Andrew[(1)] has shown that at advanced medical units it is far better to give sulphanilamide by mouth at intervals of twelve hours. Satisfactory blood concentrations of the drug are obtained, and vomiting is no more frequent than with the smaller repeated doses. It is suggested that "sunrise" and "sunset" doses of sulphanilamide should be given as a routine procedure.

Blood Transfusion at a General Hospital in the Middle East.

The second unit where blood transfusion is extensively performed is at a general hospital. During the year 1941 I saw the blood transfusion work at an Australian general hospital, which was housed in huts in the Egyptian desert. The number of patients varied from 800 to 1,500. At this hospital a special blood transfusion unit was formed by Lieutenant-Colonel L. C. Lindon, Officer Commanding the Surgical Division. This consisted of one captain, one sister and two orderlies. The sister soon became an expert in all branches of the unit's activities and she rendered most efficient service to the sick and wounded. The unit was housed in three rooms, a "bleeding" room adjoining the resuscitation ward, a preparation room and a sterilizing room. The two last mentioned were in close proximity to the operating theatre.

The majority of the Australian wounded from the first campaign in the Western Desert were admitted to this hospital. During the year 300 pints of blood were collected and administered. The average amount given to each patient was 1·8 pints. It is interesting to note that during this period nearly 600 pints of glucose and saline solution were transfused. The amount of serum required was very much less.

In a general hospital blood transfusion is most commonly required for the following conditions: (i) anæmia resulting from the primary hæmorrhage following gun-

shot wounds; (ii) secondary hæmorrhage from wound sepsis, especially in compound fractures; (iii) anæmia from chronic sepsis, most commonly due to compound fractures and burns.

Chronic sepsis produces a progressive anæmia over a period of many weeks. Repeated transfusions of two to three pints of blood are an essential part of the treatment and have saved many lives. One patient, Lieutenant G., who had sustained gunshot wounds of both knees, received 14 pints of blood over a period of three months. It was necessary to amputate the left leg above the knee. When he was evacuated to Australia, his general condition was excellent. In some of the surgical wards routine hæmoglobin estimations were carried out on all of these patients once a week, and this procedure proved to be of great value. Probably the factors contributing to this anæmia are the following: (*a*) the action of toxins on the bone marrow and probably the mature cells; (*b*) nutritional factors, as the patient's appetite is poor and dietetic fads are common; (*c*) persistent blood loss in the purulent discharge from the wound. The anæmia is usually hypochromic; it is reduced, but not always controlled, by liberal doses of iron, vitamin *B* and vitamin C. A diet rich in protein is indicated, as protein is lost in the discharges.

Blood Storage.

A limited quantity of blood, between two and six litres, was always stored at the hospital in a standard Red Cross ice chest, ice being used as a refrigerant. Ice is the most satisfactory refrigerant, as it maintains a standard temperature and there is no fear of freezing the blood. The blood was always available in acute emergencies. However, in the slow anæmias associated with sepsis, it appeared to be preferable to use blood freshly collected. The stored blood usually kept well for two weeks, when hæmolysis was revealed by a red haze which appeared above the sedimented corpuscles. Evidence of infection had occasionally occurred, but was uncommon. Rigid attention to asepsis was maintained. Periodical bacteriological control was carried out.

Blood Donors.

All the blood was collected from convalescent patients, who volunteered to give blood to their less fortunate colleagues. There was no shortage of donors. Before blood was taken, consent was always obtained from the officer in charge of the ward. The identification disks and pay books were consulted to determine the blood group. A direct test was carried out by matching the donors' corpuscles with the recipients' serum. The blood of a number of patients was typed, but no errors were found in the typing which had been carried out in Australia. During the twelve months, no complaints were received about the condition of the donors. Donors who gave a history of malaria or syphilis were rejected. No definite evidence of the transmission of syphilis or malaria was obtained, but this is a real danger. A number of blood tests for these diseases were carried out.

Serum.

Serum was not frequently required, for men with acute burns were not often admitted to the hospital, acute hæmorrhage rarely occurred and even then stored blood was always available, and cases of post-operative shock in the absence of hæmorrhage was rarely encountered. Moreover, donors who had not been in malarious zones were available. However, serum did prove of value in a number of cases, and no untoward reactions were observed, although the serum had been in storage for at least six months. The serum was wet, and had been prepared in Australia from blood donated by Red Cross donors. Some deposit was present owing to denaturation, but this was adequately removed by the standard blood filter.

Glucose and Saline Solution.

It should be noted that twice as much glucose and saline solution as blood was given during the year. Patients with peritonitis and paralytic ileus required large amounts. One patient with streptococcal peritonitis was given twenty-four pints of glucose and saline solution over a period of four days. Sulphanilamide was added to the transfusion fluid. He made an excellent recovery.

Preparation of Glucose and Saline Solution at the General Hospital.

In nine months, 700 litres of sterile glucose and saline solution were prepared and administered at this Australian General Hospital, by means of the standard "Soluvac" bottles, a tin-lined, all-metal still, and a standard hospital autoclave. Five hundred litres of this fluid were administered at the hospital under strict supervision and no reactions were observed in the recipients (rigor, chill, or rise in temperature). A few bottles were stored at room temperature for six months prior to administration. No bacterial contamination of the fluid was observed. However, it would be wise for glucose and saline solution prepared under these somewhat primitive conditions to be used within a week or so of preparation, and its distribution to other units should be discouraged.

Summary.

1. Resuscitation should be carried out as close to the front line as possible. In addition to warmth, drinks and morphine, it will be necessary to give fluids intravenously to 5% or more of the wounded.

2. Every medical unit should have one or more officers and at least four other ranks thoroughly trained in transfusion technique. Each unit must provide suitable rooms or tents for this work. When an action is pending, resuscitation teams should be sent forward to the advanced units from general hospitals and casualty clearing stations.

3. Those working in resuscitation units must learn to use their eyes, their hands and perhaps a sphygmomanometer and a hæmoglobinometer. They should be young, enthusiastic, placid and painstaking.

4. Blood is the best fluid for treating hæmorrhage. Serum is of value for hæmorrhage when blood is not available, for shock associated with little or no hæmorrhage, and for burns. Glucose and saline solution is of value in the presence of vomiting, especially in abdominal wounds, and for dehydration generally. Moreover, as an adjunct to blood or serum it is of benefit in shock and hæmorrhage. This is an important empirical observation.

5. Patients requiring transfusion will need at least one bottleful of fluid (one litre), no matter whether it is blood, serum or glucose and saline solution. Often they will require more.

6. At advanced dressing stations and main dressing stations serum and glucose and saline solution will be of benefit. If possible, blood should be brought to casualty clearing stations and main dressing stations from a reliable blood bank.

7. "Coramine" and "Neo-synephrin" (or "Veritol") will often aid resuscitation if added to the fluid given intravenously. Sulphanilamide may be given in the fluid if abdominal wounds are present.

8. At base hospitals blood storage may be carried out by skilled workers under conditions of strict asepsis and bacteriological control.

9. Chronic sepsis causes progressive anæmia. This is insidious and often passes unrecognized. Weekly hæmoglobin estimations are essential. Treatment consists of adequate drainage, a liberal diet rich in vitamins and protein, iron, and adequate transfusions of fresh blood. Amputation must not be too long delayed.

Acknowledgements.

I wish to acknowledge the help received from Colonel K. Fraser, Commanding Officer of the Australian General Hospital, and from Major E. Keogh, pathologist to the hospital.

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The Medical Journal of Australia

SATURDAY, AUGUST 8, 1942.

NOTHING FOR NOTHING AND SOMETHING FOR EVERYTHING.

In our present so-called democracy by far the greater number of people work for their living. That is to say, they are engaged in some occupation for which they receive payment. There are, as mentioned in previous discussions in these pages on the social question, two sections of the community who do not work for a living. One consists of those who are so well-to-do that they have no need to work to procure the means of livelihood; the other comprises those who will not work though they are strong enough and healthy enough to do so, as well as those who cannot work because of some illness or infirmity. It is a commonplace among many people to decry work, to assume boredom because they have to work and to sigh for a life of idleness in which their needs would be met and in which they would also have enough to satisfy any craving for pleasure that a moment might bring. Most of us know that nothing is so boring as idleness and that pleasure, undeserved and unrestrained, will soon stifle the spirit, however hungry and unsatisfied it may be. If then idleness must be earned and pleasure deserved, we must define work. There is in our present-day society an unintelligent use of the word worker. A worker is supposed to be one who works with his hands and preferably belongs to a trades union; he is supposed not to wear a white collar and his designation at once puts him in a "class" by himself. And this in a democracy should not be tolerated. To work is to expend energy. To work for a living is to expend energy and to receive in return payment of money with which the necessities of life can be purchased. Though the expenditure of energy in the body is ultimately controlled by the nervous system, we may speak colloquially and say that man may work with his hands or with his brain. But these are not mutually exclusive. What is known as manual work, as well as work that is supposed to call for use of the brain, can be done intelligently or unintelligently. When work becomes little more than the functioning of a conditioned reflex we can deny that the worker uses his intelligence. Perhaps we do not often enough think about intelligence in relation to work. A cook, for example, can by exercise of intelligence earn for himself a high place in the esteem of many people; by the study of materials and methods and the use of an inquiring mind he can become a creative artist, but most people call him a manual worker. A medical practitioner is supposed to belong to a learned profession, he has to spend years in study and in clinical observation before he is qualified to treat patients, and yet he may by lack of intelligence become almost an automaton, failing to give symptoms their true significance, to appreciate the surroundings of the patient and to apply the best form of treatment; and most people look on the doctor as an intelligent brain worker. Many others can be named—the teacher, instead of being an educator, may be a dry-as-dust instructor; a linotype operator, a compositor or a letterpress machinist may be either an intelligent cooperator in the production of book or journal or else a mere copyist and rule of thumb worker. The same kind of statement may be made about a road mender, a business manager, a typist, a railway porter or a person in almost any other occupation. In other words no hard and fast line can be drawn between what are known as manual workers and brain workers; one is as deserving of consideration as the other, the occupation of one is as honourable as the occupation of another.

If work is honourable, it also has dignity, but its dignity depends on the worker. A worker can dignify his work as he is sincere regarding its purpose and happy in its performance, and he can be happy in it only if it is work to which he is suited—a square peg in a round hole will never make a comfortable fit. In our democracy therefore the square peg should be given a chance to find a square hole of the right size and a round peg a suitable round hole. All men are not cut out for creative work. The greatest joy may be obtained from creative work; and who shall say that the creator of ideas has more satisfaction than the maker of an armchair, the writer of a sonnet than the builder of a sewer, or the inventor of a new electrical device than the stone mason in the fashioning of his house? Many people can only be copyists, but they can find or they should be able to find joy in the making of a good copy. This does not say that they should not try to create; they will have fun in making such an attempt, provided they do not take to heart the partial or complete, but withal inevitable, failure. But here, whether we are creative artists or copyists, we must think ideally and realize that the most abiding joy in work springs from a knowledge that it is done in the service and for the welfare of the community or of certain persons or groups of persons in the community as well as of self. There is no avoiding the fact that we are all servants one of another, from the King, crowned and exalted on his throne, to the youngest messenger boy just starting to make his way in the world. As servants we have certain rights and with justice claim them. Some of us have had to fight and to fight hard for bare recognition of the fact that we have rights and the ceding of them has not been accomplished

without bitterness and anguish. But the story of the rights of man and their recognition cannot be told here; indeed it could not be told anywhere because it is not yet complete. For many the fight is still on and must continue. But the matter is not quite simple. When we demand rights for ourselves and for others, we demand justice. Amiel has written that justice consists in recognizing the rights of others. In very truth here is the rub. If we have rights we have also responsibilities—to the whole of mankind, to the community in which we live, to each other as individuals and to ourselves—and thereby hangs the whole tale.

We have seen that we are all workers together, that we should take an intelligent pride in the work of our choice and clothe it with dignity; we also recognize not only our own rights but also the responsibilities that come with them. We must one and all take care how we discharge our responsibilities. At the present time there is a regrettable tendency among certain people who are earning enough to meet their reasonable needs in this time of stress, not to do any extra work unless they are paid handsomely for it. The motto is: "Nothing for nothing and something for everything." This sort of thing was not unknown before the war. To be greeted by a well-paid scientist, the acknowledged master of his domain, with the blunt question, "Is there any money it it?" in reply to a request for assistance in an endeavour to spread scientific knowledge, and to be given a curt refusal because no means of payment were available, was to discover feet of clay on the master who by common consent was thought to stand upon a pedestal. In wartime the adoption of an attitude such as this is difficult to understand. And yet it is found on every hand. The newspapers proclaim it from time to time and it is like a chain on the feet of a democracy that is stepping out to engage the enemy. The truth is that every man and every woman who are earning sufficient to meet their immediate needs should be engaged in their spare time in some voluntary activity that will be of use to the community as a whole or will help individual members of it. Apart from the war altogether, the motto "Nothing for nothing and something for everything" must go. Until the idea of personal responsibility and the ideals of service permeate every section of Australian society our democracy will be incomplete and therefore ineffective.

Current Comment.

OXYGEN AND AVIATION.

WHEN R. M. Tovell and J. E. Remlinger, junior,[1] describe the effects of oxygen lack as being similar to those produced by the taking of alcohol, there is a hint of the reason why oxygen finds so prominent a place in the interest of doctors who are responsible for the welfare of flying men. It is, of course, well known that alcohol, by depressing first the highest control centres and removing inhibitions, produces a feeling of exhilaration and well-being that masks the coincident loss of efficiency for quick, delicate and intricate activity, and is followed by progressive depression of cerebral function that terminates in coma and even sometimes death. It is this early euphoria and unrecognized loss of efficiency and the coma and death that may follow so unexpectedly which make oxygen lack so important a subject to the aviator. It is no wonder that it receives perhaps more attention than any other topic in H. G. Armstrong's book, "Principles and Practice of Aviation Medicine".

Probably all medical men are well aware that as one rises above the earth the partial pressure of the oxygen in the atmosphere steadily decreases, and so, too, does the amount of oxygen that is absorbed by the lungs. When the aviator rises above 12,000 feet symptoms of oxygen lack begin to develop. The longer he stays there or the higher he rises, the more serious the symptoms become. Early in the history of aviation these symptoms were noted. In 1786, three years after the first successful balloon flight was made, a handbook of aviation stated that "The spirits are raised by the purity of air and rest in a cheerful composure. In an ascent all worries and disturbances disappear as if by magic. . . ." It was not till about 1875 that Paul Bert, a French physiologist, suspected and soon proved that this strange "balloon sickness" was caused by oxygen lack. In that year his friend Tissandier and two colleagues made a high altitude balloon flight, and Bert persuaded them to take a supply of oxygen. Unfortunately their supply was too small and their knowledge of its use too limited, and Tissandier became unconscious while his two comrades died. Armstrong quotes part of Tissandier's description of the flight: ". . . at 24,600 feet the condition of torpor that overcomes one is extraordinary. Body and mind become feebler. . . . There is no suffering. On the contrary one feels an inward joy. There is no thought of the dangerous position; one rises and is glad to be rising. I soon felt myself so weak that I could not even turn my head to look at my companions. . . . I wished to call out that we were now at 26,000 feet, but my tongue was paralysed. All at once I shut my eyes and fell down powerless and lost all further memory."

The name usually given to the symptom complex produced by oxygen lack in aviation medicine is altitude sickness. Its gravest danger lies in the almost complete absence of distressing symptoms before the onset of incompetence or coma which are so likely to result in death. "There are few, if any, other conditions known to medicine which produce such profound changes in the body, or which may even produce death without creating more pronounced subjective manifestations than those experienced in acute altitude sickness." Thus writes Armstrong, and with very real truth. As the pilot ascends above 12,000 feet he may feel a little languid and sleepy or suffer from slight headache, or on the other hand he may feel the exhilaration and inward joy that Tissandier felt, that life is one grand adventure and that his is the grandest life of all. Seldom does he feel symptoms that distress or frighten him, and seldom does he realize that he is in danger unless he has been very clearly taught the significance of these early warnings, if a feeling of well-being can be called a warning. Nor does he realize that his ability to reason clearly, to act quickly or to shoot a gun straight is fast disappearing. He does not even realize that the other members of his crew are losing their efficiency. He does not think it strange if they indulge in bursts of hilarity or become pugnacious or simply foolish in their conduct. The higher he flies, the more likely are these symptoms to appear. At 25,000 feet he is likely to become comatose, rather suddenly and with little warning. To an observer who is using oxygen these changes are easily apparent. It is easy to demonstrate the loss of neuro-muscular control of the person without oxygen. His writing becomes illegible. With a camera gun he cannot hit the simplest of targets. His mental changes are just as easily observed. He fails in the simplest arithmetic exercises, his judgement, memory, attention and self-criticism become obviously impaired, and he develops fixed and irrational ideas. His pulse rate and blood pressure become altered and these changes may end in fainting. His respiration becomes increased in depth. He may become comatose without any cardio-vascular changes. His electrocardiograph shows deformity of the *QRS* complex, inversion or lowering of the *T* waves and depression of the *RT* interval. Finally, if his aircraft stays above about 25,000 feet he certainly dies.

[1] *The Journal of the American Medical Association*, December 6, 1941.

The tolerance of altitude without oxygen varies with individual pilots. Emotional instability or the recent taking of alcohol greatly decreases this tolerance. The rate of ascent, the length of the flight, the height reached and the physical fitness of the flier are all of importance in determining how severe will be the symptoms and how early they will appear.

It is easy to see how important the subject of altitude sickness is in modern aviation medicine, for today long flights at altitudes above 20,000 feet are made every day. It is of the utmost importance for the pilot to know that the inward joy he feels as he rises is not a sign that he is a grand and able fellow, but a sign that he is losing efficiency and judgement and control, a sign that he should have started to use his oxygen apparatus several thousand feet below. It is said that during the last war, when fliers had less knowledge of the value and use of oxygen than they have today, pilots sometimes went up to engage the enemy, but, overcome by the early symptoms of oxygen lack, flew gaily along beside their antagonists cheerfully waving to them, or having set out to photograph enemy territory, brought back pictures of their own country, though they were certain they had exposed their films over that of the enemy. It is said, too, that in the cockpits of some of the German planes shot down in this war has been printed the motto: "Oxygen wins air battles." Seldom has any motto contained more truth.

To complete this discussion reference should be made to the use of oxygen in commercial aviation and the subject should also be linked up with the effects of aviation on the ear—a subject recently mentioned at some length in these pages. But we must forbear. There is no doubt that greater heights and greater rates of climb will be achieved by the combat planes of this war. There is no doubt that after this war air travel will be used ever so much more widely than ever before. It is plain therefore that aviation medicine will come to interest an ever larger number of medical men, both in the realm of research and in the much more common realm of ordinary practice. And almost certainly the most prominent place in this new interest will be taken by oxygen and its relation to altitude flight.

JUVENILE EMPLOYMENT IN GERMANY.

The article on German psychological warfare published in the *British Medical Journal* of April 4, 1942, aroused considerable interest among Australian readers. Apart from the general interest associated with such an article it is important that Australians should know as much as possible about their antagonist, especially of his mental outlook and of the way in which he organizes his resources. Germany has become known as the country where thoroughness is to be found in a highly developed form; but we should not lose sight of our own ability to be thorough in our organization and in the execution of our plans. That readers may know more about the organization of the German nation we propose to give a short account of the main points in a report on juvenile employment in Germany published in the *International Labour Review* for May, 1942. This journal is issued by the International Labour Office, now functioning in Montreal, Canada, but formerly of Geneva, Switzerland.

The report is based on a series of articles published in *Reichsarbeitsblatt* and one of these is from the pen of Franz Seldte, German Minister for Labour. The articles appeared in October, 1941, and may be regarded as describing the conditions existing in Germany at that time. A complete reversal in the juvenile employment situation took place when the National-Socialist Party seized power. In 1934 about 620,000 boys left school, but the number of vacancies open to them was about 155,700; in 1939 the corresponding figures were 530,000 and 582,000; in 1940 the number of vacancies fell slightly to 558,000, but in 1941 it rose sharply to 627,100, and of these vacancies about 200,000 remained unfilled. The boys naturally went into the more popular occupations, and among these were metal working and work in commercial offices. Something had to be done, so in March, 1938, juveniles leaving school were compelled to report and apprentices, probationers and learners could not be engaged without the approval of the competent employment office. Employment offices were also empowered to call up young people about to choose an occupation together with their parents for an interview. Though a rational employment policy for boys could be worked out in this way, a difficulty arose from the fact that the number of boys leaving school would decline until the year 1947. It thus became all the more necessary in the interests of national economy to pay attention to the number of recruits which each occupation ought to receive. A Juvenile Employment Plan was made and was put into full operation in 1941. It applies only to boys who do not mean to take up an academic career, to join the armed forces or to enter the civil service. Any use of direct compulsion is disclaimed, but when the quota for one occupation is filled additional recruits to it are refused and another occupation must be sought. The work is done in collaboration with schools and the Hitler Youth Movement. The main object of the employment office is to discourage boys from seeking the popular occupations and to persuade them to view with more favour the unpopular occupations (agriculture, mining, textile, clothing and building industries and wholesale and retail trading).

The results of the plan for 1941 are stated in regard to certain occupations. In some instances the efforts were successful, in others not. In agriculture it was intended that the number of entrants should be raised from 100,000 to 115,000; the result was 5,000 short, but was thought to be satisfactory. In mining the failure was bad; instead of an increase from 9,000 to 15,000, a drop to 7,000 occurred. An increase was secured in the chemical industry; a surprising increase in entrants for hairdressing occurred and the plan's efforts to check the increase failed. Further figures might be given, but these will suffice to show that apparently "persuasion" is not always successful and that compulsion is not used. The only result regarded as indicating a serious failure was that concerned with mining, and it is intended to "tackle the underlying causes which are impeding the flow of juvenile entrants into this occupation".

The Juvenile Employment Plan does not apply to girls. The number of girls leaving school is about the same as the number of boys, but the number of vacancies for girls in skilled or semi-skilled occupations is less than half the number of girls leaving school. A large proportion of girls enter occupational life, not through some system of technical training, but by way of unskilled "help" or as members of a family group. The technical training of girls is by no means as thoroughly organized as that of boys and such provisions as do exist are much less strictly applied. In the two main occupations in which women are active, agriculture and domestic service, there is no preliminary period of training. "The truth is that the situation as regards the securing of an adequate flow of juvenile entrants is as strained in the case of girls as in that of boys . . ." Apparently, too, many girls prefer work in commerce and offices and this is regarded as unsound. Too few wish to be employed in agriculture and in the textile industry. A large number show no preference for any specific occupation and this is considered as indicative of the uncertain way in which many girls and their parents still face the problem of the choice of an employment. Girls ask themselves whether they ought to undergo a course of technical training. Managers ask themselves whether they require a regular supply of technically trained girls or whether they should merely employ women as a labour reserve to be used when the supply of men runs out. The Ministry of Labour has no doubts and believes that girls should not be employed in industry until they have undergone a regular course of vocational training. The authorities do not think it necessary to introduce a plan for girls like that for boys, but they think that in addition to the course of vocational training the occupation should be made as attractive as possible.

Abstracts from Medical Literature.

BACTERIOLOGY AND IMMUNOLOGY.

Uses of Nigrosin.

ALEXANDER FLEMING (*The Journal of Pathology and Bacteriology*, September, 1941) has discussed the various uses of nigrosin in bacteriology. He used a 10% solution of the dye dissolved in 10% formalin and applied it to the "negative staining" of bacteria to show their form and arrangement, spore and capsule formation, and in combination with "positive staining" methods. He found nigrosin superior to Indian ink, and convenient in that it is water-soluble and can be washed away if it is desired to stain the slide with a contrast stain.

Immunity in Tuberculosis.

MAX B. LURIE (*The Journal of Experimental Medicine*, March, 1942) has continued his studies in tuberculosis by determining the fate of tubercle bacilli ingested by mononuclear phagocytes derived from normal and from immunized animals. He devised methods whereby the phagocytes from lymph nodes of infected normal and immunized rabbits were concentrated by centrifugation and washing of the excised lymph node, and then injected into the anterior chamber of the eye of normal albino rabbits. After fourteen days the animals were killed and the condition of the implanted phagocytes and their ingested tubercle bacilli from the original animal was investigated qualitatively and quantitatively. A further series of experiments was performed in which the fluid in the anterior chamber was withdrawn and replaced either by normal rabbit serum or immune serum. The results showed that phagocytes from an immunized animal continued to inhibit the growth of acid-fast bacilli when transplanted to a normal animal, and showed a greater effect when transplanted to immune serum in a normal animal. Immune serum added to the phagocytes of a normal animal does not help them to inhibit the growth of tubercle bacilli during this test period. Longer periods were not investigated. The final conclusion of the experiments was that the existence of active tuberculosis in the animal body renders the mononuclear phagocytes more effective in arresting the multiplication of tubercle bacilli, and that this quantity is not related to the presence of immune bodies in the serum or the tissue in which the phagocytosis takes place.

Pleuropneumonia-Like Organisms.

H. BEEUWKE AND W. A. COLLIER (*The Journal of Infectious Diseases*, January-February, 1942) have made further investigations on arthrotropic pleuropneumonia-like organisms. Two strains, one from spontaneous disease in a rat, and one from blood and articular fluid of a patient with rheumatic fever, were tested. Appearances in specially prepared serum broth and serum agar were examined. Owing to the small size of colony and organism, methods of staining the whole culture were employed, methylene blue or Victoria blue R being used. The microscopic morphology showed considerable pleomorphism, although the agar cultures showed more of the so-called globular, corpuscular forms. The organisms were aerophilic, and the pH of several carbohydrate media showed a fall after three days' growth of the organism in them. Filtration through Seitz EK and Chamberland L3 filters did not remove the infective agent from fluid cultures. This test was performed on rats which as far as was possible were shown to be free of pleuropneumonia-like organisms. The pathological lesions in the test animals were polymorphonuclear and fluid exudates in the soft parts of the feet and the synovial cavities, followed by osteophyte formation and involvement of the marrow. The two strains of the organism, one of animal, the other of human origin, showed no differences, either in culture or lesion in normal rats.

Antibacterial Action of Sulphonamides.

W. BARRY WOOD, JUNIOR (*The Journal of Experimental Medicine*, April, 1942), has investigated the quantitative relationship between para-amino-benzoic acid and six of the sulphonamide drugs. He used a synthetic medium and a strain of *Bacillus coli* which was not altered in its rate of growth by the presence of para-amino-benzoic acid. The bacteriostatic effect of all six drugs showed a direct proportion to their ability to withstand the addition of para-amino-benzoic acid to the medium. The bacteriostatic effect of each drug was nullified by para-amino-benzoic acid, even though they differed markedly in chemical structure. When all conditions of the experiments except the concentration of the drug were kept constant, the ratio of para-amino-benzoic acid to the drug was also found to be constant. These results indicate that the theory of Woods in relation to the bacteriostatic effect of the sulphonamide drugs, namely, that it is due to inhibition of enzyme action in the bacterial cell owing to interference with an essential metabolite, has received further confirmation. The author is designing further experiments to identify the enzyme system involved in the utilization of para-amino-benzoic acid by the cell.

W. BARRY WOOD, JUNIOR, AND ROBERT AUSTRIAN (*ibidem*) have investigated the relationship of drug activity to substances other than para-amino-benzoic acid. As Fildes had drawn attention to the chemical relationship between sulphapyridine and nicotinic acid and between sulphathiazole and thiamin, it appeared that drug activity might depend on interference with the chemically related enzyme or vitamin. Cultures of *Staphylococcus aureus* were used, on which the vitamin or enzyme used was known to have a growth-stimulating effect, and it was found that the growth stimulation was not prevented by either the chemically related or the different sulphonamide, and the antidrug effect shown by these substances was proportional to their growth-stimulating property. The authors put forward the suggestion that the action of all sulphonamide drugs depends on their capacity to inhibit the metabolism of para-amino-benzoic acid, the more potent drugs having the more powerful inhibition of the enzyme concerned in its utilization. They are making further studies to identify the enzyme concerned in this apparently vulnerable cycle of bacterial metabolism.

Cervical Smears in Clostridium Welchii Diagnosis.

HILDRED M. BUTLER (*The Journal of Pathology and Bacteriology*, January, 1942) has continued her investigations into the presence of *Clostridium welchii* in the genital tract of women who had had abortion. Previous studies had given support to a classification of strains into three groups of decreasing pathogenicity, and the author endeavoured to use the examination of cervical smears as a means of rapid diagnosis in severe *Clostridium welchii* infections following abortion. Eighty-four swabs were obtained from patients from whom positive cultures were obtained; they fell into the three groups. Smears were stained by the Jensen modification of Gram's stain and by Richard Muir's capsule stain. The capsulation was described in terms of width in relation to bacillary width. In the 20 severe infections capsules were heavy, and the inflammatory cells showed marked disintegration. In 20 cases in which presence of *Clostridium welchii* was suspected on clinical grounds eight swabs proved "negative", and when smears were "positive" capsulation was slight and leucocytes were little damaged. In 44 cases in which there was no clinical evidence of infection, the cultures were positive, and the smears varied considerably in appearance. Heavy capsulation was in a small minority, and undamaged leucocytes showing a marked degree of phagocytosis were numerous, while in six instances no capsular material could be identified. The method was thought to have a place in the early rapid diagnosis of severe infection.

HYGIENE.

Industrial Medicine.

IN an article on the private physician's opportunity in industrial medicine, J. J. Bloomfield (*The New England Journal of Medicine*, December 11, 1941) draws attention to the need in industry for medical and surgical care to effect prompt restoration of health and earning capacity following disability, for the prevention of disability in industry by the proper control of the working environment, and for the promotion of health among workers. To assist physicians in their work along these lines the Council on Industrial Health of the American Medical Association has suggested a definite procedure. It includes such functions as periodic inspection and appraisal of plant sanitation and occupational exposures, followed by the adoption and maintenance of adequate control measures. The provision of first aid and emergency services and the prompt and early treatment of all illnesses resulting from occupational exposure are significant functions of the medical department. Impartial health appraisals of all workers and provision of rehabilitation services for the correction of defects are additional functions of a medical department. Finally, by means of the recording and decreasing

of absence due to all types of disability, it should be possible to make real progress in reducing the time lost by workers, thereby not only benefiting the worker's physical well-being, but also yielding tangible monetary advantages to both employer and employee.

A Search for Poliomyelitis Carriers.

G. Y. McClure and A. D. Langmuir (*American Journal of Hygiene*, March, 1942) have made a search for carriers in an outbreak of acute anterior poliomyelitis in a rural community. Forty stools were tested for virus. Virus was found in the stools of four out of five patients, and in those of 20 out of 27 contacts. In these, mild bowel upsets were fairly common. Virus was not present in the stools of four who had had the disease in the past or in those of four who had no evidence of contact with the patients. Stools were treated with lauryl sulphate and ether, to prevent fatal peritonitis on intraperitoneal injection into monkeys. Clinical and typical paralysis, followed by passage of the virus to a second monkey, and typical cord lesions found *post mortem* in the first monkey are taken as positive evidence that the subject is a carrier.

Toluene.

L. Greenburg, M. R. Mayers, H. Heimann and S. Moskowitz (*The Journal of the American Medical Association*, February 21, 1942) describe the effects of exposure to toluene in industry. Toluene is used in aeroplane paints, and it has tended to replace benzene (benzol) in other industries. One hundred and six painters in an aeroplane factory were examined. There were 51 spray painters, 25 dip painters and 30 brush painters, all exposed to toluene for periods varying from two weeks to as much as five years. Five men had perforations of the nasal septum, thought to be due to zinc chromate in the spray, 32 men had enlarged livers, eight men had a diminished number of red cells in the blood and 18 had raised hæmoglobin values; the number of lymphocytes was increased in 20% of cases. None of the men had any symptoms of ill health. Thirty-four *per centum* of the men had macrocytosis. Means were taken to protect the workers from fumes by exhaust fans and by adequate ventilation; nevertheless, the men were exposed to between 100 and 1,100 parts of toluene per million during working hours. There was a similar exposure to other hydrocarbons, which were not regarded as toxic in the amounts inhaled.

W. F. von Oettingen, P. A. Neal and D. D. Donahue (*ibidem*) report results of investigations into the toxicity of toluene. This substance is used extensively in aeroplane and explosives factories. It had a stronger narcotic action than benzene, but has less severe effects on the blood and blood-forming organs. Experiments were carried out on three normal persons between the ages of eighteen and fifty-three years. These subjects were exposed to varying concentrations of toluene under average conditions of moisture and temperature; routine work was carried out during the experiments, which lasted for eight hours. Concentrations of 200 parts per million caused impairment of coordination and reaction time, which was dangerous to their safety and to the safety of their work. Higher concentrations caused more severe effects of this kind in a few hours. Excretion of hippuric acid and concentration of toluene in the blood increased with the concentration of toluene in the air.

Health in Wartime.

Grant Fleming (*The Canadian Public Health Journal*, April, 1942) states that we all fall into two groups, those who serve in the forces and those still in civil life. Nine times as many will remain in civil life as will enter the army. Disease can spread from one group to the other. Industry finds the weapons of war and relies on the health, physical and mental, of industrial workers. The urgent need is health. We cannot afford to have anyone sick. As a war measure we should ask for laws, and for their enforcement, to pasteurize town milk supplies, to safeguard water and to immunize the population against diphtheria. In industry health standards must be raised, so that the greatest and best production will be reached, apart from the avoidance of lost time due to illness or accident. "All-in" drives against venereal diseases and tuberculosis must be made. If X-ray pictures are of use for soldiers, they are just as useful for workers. Housewives in an area should be enlisted to aid the war by proper feeding of their families. Mental health must be developed. Medical care for all persons is essential. We must be insistent on services for children, active for adult health and far-sighted in planning medical care.

The Royal Australasian College of Surgeons.

SYMPOSIUM ON BLOOD TRANSFUSION.

A symposium on blood transfusion was held at the Royal Australasian College of Surgeons, Spring Street, Melbourne, on April 17, 1942.

Collection and Storage of Blood, Blood Serum and Blood Plasma.

Lieutenant-Colonel C. W. Ross read a paper entitled "The Collection and Storage of Blood, Blood Serum and Blood Plasma" (see page 91).

Transfusion by Direct Methods.

Dr. Julian Smith read a paper entitled "Transfusion by Direct Methods" (see page 92).

Transfusion by Indirect Methods.

Dr. Cyril Fortune read a paper entitled "Transfusion Using Indirect Methods" (see page 94).

Transfusion in the Middle East.

Lieutenant-Colonel Ian J. Wood read a paper entitled "Some Observations on Transfusion in the Middle East" (see page 97).

Discussion.

Lieutenant-Colonel Julian Smith said that he had come to the meeting purposely unprepared, wishing to hear first what others had to say; but in view of some of the comments he intended to make, he asked the Director-General of Medical Services to regard his contribution to the discussion as a privileged communication. Referring to his experience in the Middle East, Colonel Smith said that the work of the surgical team to which he was attached began at the first Battle of Bardia, and one of the team's responsibilities was resuscitation, especially blood transfusion. The surgical team included one other medical man, Major Douglas Stephens, and Colonel Smith paid a tribute to the excellent work done by him.

Colonel Smith went on to say that it was well known that the medical men in a surgical team during the last war were a surgeon and an anæsthetist; in his opinion, the latter was simply a man wasted. If there were only two medical officers, then the second had to be available for resuscitation or for surgical work, and he had no time to give anæsthetics. In the surgical team to which Colonel Smith belonged there was an orderly, a barman from Rochester. After some months this man became a competent anæsthetist and a good surgical assistant, and he could be trusted to take blood from donors. The team, on its arrival at Bardia, was greeted on all sides by condemnation of the "Soluvac" system. In the resuscitation tent transfusions were being given with a tube and funnel. The "Soluvac" apparatus was considered "no good", because, when it was to be used for the taking of blood, simple minor adjustments were necessary in the particular Higginson bulbs supplied. The whole system was in the discard, simply because those in charge did not know how to use it. Things were not satisfactory, and before the first battle of Tobruk (January 21, 1941) the Assistant Director of Medical Services asked Colonel Smith if there was anything he wanted; Colonel Smith replied: "Yes—a good resuscitation man." Lieutenant-Colonel Ian J. Wood was sent up, and Colonel Smith, without being in any way egotistical, considered that they had "turned on a fair show". At one period they worked without rest for forty-six hours, and in the end it was not so much they who became depleted as their equipment; such were the difficulties of supply that they were short of water and lacked methylated spirits and kerosene. It was during this period that the short-term blood bank was used for the first time in the Middle East. Plenty of donors were available, and a considerable quantity of blood was taken before the battle. They knew when the battle was going to start, and they were confident as to when it would finish. The blood was stored in Red Cross ice chests, and the ice, which Colonel Wood had brought with him from Alexandria (over 300 miles distant), they used in their drinks eight days later.

With regard to Syria, Colonel Smith said that there they were working in a casualty clearing station in *de luxe*

quarters. They had running water and electric light, and again they successfully set up a miniature blood bank. However, the stored blood was used exclusively in the unit, and there was a quick "turnover", so that little of it was more than a few days old. Colonel Smith pointed out that the miniature blood bank was not without its dangers; he said that no blood bank was free from danger without accurate bacteriological control, which could not always be provided in the field. Referring to refinements of technique, Colonel Smith said that he thought that at times medical officers were apt to be too scientific. Hypoproteinæmia might have been rife in the Western Desert, but he did not encounter it; nor had he used a hæmatocrit. Such niceties might be used to give flavour to transfusion in the relative peace and quiet of base hospitals, but such scientific knowledge and apparatus were to him actually unpalatable, when introduced into a discussion of transfusion in war, the main problems of which were surely to be dealt with in the field. It could hardly be considered a diagnostic triumph to assert, if a man had had his leg almost blown off and was pale and pulseless, that he needed blood. They relied mainly on the "feel" of the pulse and the facial appearance. Although at times those criteria did give an accurate index of vasomotor activity as determined by blood pressure readings, they were rarely misled; but occasionally men in apparently poor condition were found, when checking was carried out, to have an unexpectedly high blood pressure. One man, to whom Colonel Wood had referred in his paper,[1] was known as "the dead man". He was a gunner whose arm had been blown off by a land mine. When he came into the care of the surgical team he was pulseless, cold and white; his eyeballs were turned up and his respirations numbered about six per minute. Colonel Smith considered his condition hopeless. However, within four minutes a blood transfusion was being given, and he received six pints of blood within the next twenty-four hours, when he was fit to be taken to the operating theatre.

Colonel Smith said that the problem of blood transfusion and resuscitation still faced them. How were they at present and in the near future to provide this service? He firmly believed that they should use the tool they knew, and as the Australian Army Medical Corps knew the "Soluvac" apparatus, it would be most unwise to change it at the present time. When it was used by those who understood it, the apparatus provided a convenient and efficient method of giving blood. One insuperable disadvantage of the direct method of blood transfusion in forward casualty clearing stations lay in the fact that there was a limit to the number of transfusions in operation at the one time. At a base hospital the direct method certainly had a place, especially, Colonel Smith thought, in anæmias following sepsis.

Colonel Smith then referred to the question of which medical units in the field should provide for blood transfusion, and how far forward it was possible to provide such a service. He thought that the tendency would be for plasma to replace blood in forward areas, for two reasons: firstly, because of the difficulty of storing blood, and secondly, because of the difficulty of transporting it. However, if a man was suffering from severe blood loss, in the end he would need a blood transfusion; plasma might serve as a temporary expedient, but it would not replace hæmoglobin. Colonel Smith believed, therefore, that transfusion facilities should be pushed forward, certainly at least as far as the main dressing stations, and that the surgical service should remain further back. In the beginning it was always their aim to be near the casualties and operate on them early, but their opinion had absolutely changed. Apart from men with abdominal wounds (and, however early these were dealt with, a certain fixed percentage would die), life was not jeopardized by the additional time taken to transport casualties to efficient surgical aid in a casualty clearing station. The time taken to transport a casualty from the battlefield to the main dressing station (which was the most forward site at which a surgical team could function) was much greater than the time taken to bring him from the main dressing station to the casualty clearing station. Therefore forward operating teams had a limited scope, and were justified only in occasional circumstances.

In conclusion, Colonel Smith expressed the hope that he had not trodden too severely on the toes of any previous speaker; but he thoroughly disagreed with much that had been said, and he considered that the symposium provided the right occasion for him to say so. Colonel Smith knew that Colonel Wood had given credit to others; but he (Colonel Smith) wished to say that any success which their team achieved in the hectic three days of the first Battle of Tobruk and subsequently during their work on battle casualties in the Middle East, was due in great part to the help they had from resuscitation methods, which owed their origin to the work of Lieutenant-Colonel Wood and Lieutenant-Colonel Ross.

[1] Most of the case histories have had to be eliminated from Lieutenant-Colonel Wood's paper owing to lack of space.—EDITOR.

MAJOR STANLEY WILLIAMS said that he felt inspired by the remarks of the previous speakers, particularly those of the family of Julian Smith; as Mr. Churchill might have said: "What a chip, what a block." There were many controversial points about transfusion work. Major Williams agreed that the "Soluvac" apparatus was satisfactory, provided that the users knew all about it. There were traps with the apparatus, and those who were not familiar with it got into all sorts of trouble when they came to change the bottles during the administration of fluid, although they had seen it in the field ambulance. When one had the essential knowledge of the method of use, the bottle was quite satisfactory.

Major Williams said that his main reason for taking part in the discussion was to justify the great amount of work that had been done in Australia, and started in Melbourne, on the use of serum, particularly liquid serum. By the cooperation of a large number of workers, supplies had been taken by him to the Middle East in October, 1940. That liquid serum was packed in ordinary wooden cases, and the cases were treated on the ship and in course of transit just as ordinary baggage of the unit; they received even rougher treatment than his own trunk. They lay on the wharf in Bombay for seven or eight days of high temperature, and those present would understand what was meant by the high temperatures of the Middle East. The serum passed through a summer and winter, still treated as ordinary baggage. At the end of six months one bottle was given to a Maltese gunner; he had had a tumour removed, and he suffered from shock with not a great deal of hæmorrhage, so he was given 600 cubic centimetres. He suffered no reaction, and his condition improved. Finally he recovered, went back to Malta and was married.

Major Williams went on to say that after a few more successes the serum was distributed a little more extensively. His own unit was in Palestine, a considerable distance from any action. Finally, after going to Mersa Matruh in the desert, he was again a long way from action. The serum was brought back again to Palestine and then to Syria, where it was used twelve months after its collection; it was given to casualties, whose condition improved, and who suffered no reaction. Thus much work had been done. Major Williams said that there were many other fluids that were good, and all those present knew various points about the ideal solution for intravenous use. However, liquid serum seemed to have stood up to tests under varying conditions. It travelled perfectly without refrigeration, and it kept for at least twelve months under those conditions.

MAJOR N. J. BONNIN said that most of the ground had been ably covered by previous speakers, and that he had not much to say. However, he had had some experience in the use of stored blood in Syria and in the last desert campaign, and he thought that a few words on the subject might be of interest. In the Syrian campaign he was with a field ambulance, and they used large quantities of dried and wet serum and of fresh and stored blood. Transfusion arrangements were at times improvised or hurriedly made, but on the whole worked fairly smoothly, although they had had an unfortunate experience with one batch of stored blood; it was contaminated. That blood was taken at a small branch transfusion unit, and proper aseptic technique had apparently broken down. The unit concerned was not part of the Australian Imperial Force. In the Libyan battle Major Bonnin was attached to the Middle East forces as commanding officer of a field transfusion unit, which was attached to a mobile military hospital. Blood transfusion arrangements were well organized under Major Buttle, commanding officer of the base blood transfusion unit. All blood was taken at this base unit under Major Buttle's personal supervision. All apparatus was prepared and sterilized at the base, and no attempt was made at the cleansing or sterilizing of apparatus in forward areas. Blood was sent forward by aeroplane to five field transfusion units and given under the supervision of the officers in charge of these units. The supply of blood was lavish, and instructions were issued that any blood whose appearance was not entirely satisfactory was not to be used, and was when possible to be returned to the base for examination, and any blood over three weeks old was to be discarded. Dirty apparatus and empty bottles were returned to the base by aeroplane. Major Bonnin said that there was virtually no trouble with this stored blood, and no other method of transfusion could have replaced it. Work came in too

rapidly for fresh whole blood to be used. In that particular desert campaign he saw the casualties days and even up to a fortnight after they had been wounded. Hæmoglobin values were consistently low, in the severely wounded averaging from 50% to 60% (Sahli), and wounds were often heavily infected. Serum in those cases seemed to be contra-indicated if whole blood could be given. Stored blood was the only practicable and satisfactory transfusion fluid for the casualties Major Bonnin saw, and in the circumstances in which he saw them. In a series of transfusions of 80 pints of blood which he administered, 15% of the bottles caused reactions. These reactions took the form of chills or sometimes rigors. The transfusion was stopped immediately if a reaction occurred, and another bottle was used. There were no serious or fatal reactions. Of bottles of blood sent back to the base, about 10% were found to be infected. It had been stressed by Lieutenant-Colonel Julian Smith that there were dangers in stored blood. However, from his own experience, Major Bonnin considered that, provided blood was taken under expert supervision in a properly equipped unit at the base, and was sent forward under good conditions (preferably by air), and checked, and administered by specially trained officers, stored blood was safe to use and absolutely invaluable. No other method of transfusion could adequately replace it.

With regard to the use of serum, Major Bonnin said that in both Syria and Libya serum was most used forward of the point where blood could be given. It was found not practicable to use blood further forward than operating teams could go; that meant, not further forward than casualty clearing stations or the main dressing stations of field ambulances. Further forward of that point, however, casualties did need transfusion, and need it urgently, and in these circumstances serum could be given. In the Libyan battle it was given by regimental medical officers as well as at advanced dressing stations a little further back. Serum also served as a useful emergency transfusion fluid in operating theatres or anywhere along the line of evacuation when blood was not immediately available. Cases in which serum was indicated for medical reasons were, in his experience, rare. Major Bonnin saw few men with serious burns, and most of those had other injuries as well. For the average battle casualty blood seemed to be the ideal fluid. Since serum was likely to be used in advanced positions and in sudden emergencies, the method of packing was of great importance. If dried serum was supplied, the reconstituting water should be packed in the container with it, and in the same container there should be an adequate number of fully assembled "giving" sets complete in every detail. The great advantage of serum was that it provided a means of giving transfusion when casualties most needed it and when it was likely to do most good—soon after the injury.

Major Bonnin then brought to the notice of the meeting a novel method of administration of blood by injecting it into the bone marrow instead of into a vein. He said that the technique was described by L. M. Tocantins and J. E. O'Neill in the issue of *Surgery, Gynecology and Obstetrics* of September, 1941, at page 281. Major Bonnin had read the article in the desert, and had had the opportunity of trying it in only one case. The patient was a man who had suffered severe multiple limb injuries with considerable hæmorrhage and shock. Three pints of blood were given into the only available vein; but the needle was jerked out of the vein when the patient was moved from the operating theatre. The *manubrium sterni* was punctured with an ordinary transfusion needle, and after the needle had been cleared of bone fragments with a stylet, blood ran in freely at about 80 drops per minute and a further two pints were given in that way. There was no trouble of any kind, and the patient was in good condition five days later when Major Bonnin lost sight of him. Major Bonnin said that the method had many advantages. The needle was well out of the way and was firmly fixed in the bone. The technique might prove most useful for restless patients with few or difficult veins; such patients were not uncommon.

Correspondence.

THE BLOOD GROUPS: THE RH FACTOR AND THE M AND N FACTOR.

SIR: In your "Current Comment" of June 6, 1942, you bring before your readers the question of the RH factor, discovered in 1940 by Landsteiner, with the aid of an immune serum prepared by injecting the blood of Rhesus monkeys into rabbits.

In your wisdom your final paragraph states: "It can be seen from this summary that some aspects of the problem raised need further elucidation and final confirmation." It is to be hoped that Australian workers will take this to heart, and will be chary in introducing it in practice. This reminds one forcibly that, also in connection with the M and N factors, there are some aspects which require elucidation not only by the medical profession, but also, and still more so, by the legal profession. The legal profession, even judges, seem to be of the opinion that, with the discovery of the M and N factors, the determination of paternity has been definitely settled. This is by no means so, and I may state that, for some years, I have flatly refused to give evidence in cases where the M and N factors and the legal aspect of paternity are being disputed.

To begin with it is not generally understood by either profession that proof of paternity cannot be established from the blood groups. Their value lies in the fact that it is possible, in some cases, to disprove paternity. Let me quote from the publication "The Research of Paternity by the Blood Groups" by Dr. Christiaens, of the Hæmatology Laboratory of the Institute for Legal Medicine and Social Medicine of Lille.

The laws of heredity, so far as the four principal blood groups O, A, B, AB are concerned, can be stated as follows:

First Law.—The factors A and B, which dominate O, cannot appear in a child unless they are present in the parents. From this the following corollary arises. (*a*) The factors A and B may be absent in the child even when present in the parents. (*b*) The factor O may appear in the child, even if it is not present in the parents.

Second Law.—Parents of group O cannot have a child of group AB. Parents of group AB cannot have a child O.

The following tables illustrate the above statements.

Parents.	*Possible Child.*	*Child Not Possible.*
O × O	O	A, B, AB
A × A	O, A	B, AB
O × A	O, A	B, AB
B × B	O, B	A, AB
O × B	O, B	A, AB
A × B	All groups	Neither group
O × AB	A, B	O, AB
A × AB	A, B, AB	O
B × AB	A, B, AB	O
AB × AB	A, B, AB	O

Mother.	*Child.*	*Impossible Father.*
O	O	AB
O	A	O, B
O	B	O, A
A	O	AB
A	A	Neither
A	B	O, A
A	AB	O, A
B	O	AB
B	A	O, B
B	B	Neither
B	AB	O, B
AB	A	Neither
AB	B	Neither
AB	AB	O

As examples to show the impossibility to prove paternity, the following two cases can be stated:

Mother O, husband A, the child is A. That child can be legitimate. But it by no means excludes a third party who is, or may be. of the same group as the husband.

Mother O, husband A, child B. In that case it can be stated with absolute certainty that the child is not legitimate. A third party of group B must have appeared on the scene. If a suspected person is then shown to be B, this by no means proves his guilt; another person, also B, may be involved.

Exactly the same reasoning must be applied to the M and N factors. The following table shows this exclusion.

Mother.	*Child.*	*Father Cannot Be.*
M	M	N
MN	M	N
N	N	M
MN	N	M
M	MN	M
N	MN	N

That the factors M, N and MN have been introduced lies in the fact that the laws of heredity are infinitely more simple. Here there are two dominating factors, but no receptive one, like the O in the O, A, B, AB system.

This is seen in the shortness of the M, N, MN exclusion table when compared with the O, A, B, AB table.

It is said that the chance of proving innocence is one in four in the O, A, B, AB grouping, whereas it is one in two in the MN grouping. However, the MN grouping gives as little proof of paternity as the other system. It is merely a question of exclusion.

But the advantages which the MN factors may have over the other system are put to nought here in Australia, and this is the point I wish to stress.

In principle the determination of the MN groups is as simple as that of the O, A, B, AB groups.

But whereas in the latter it is simply a matter of finding sera anti-A and another anti-B, which are plentiful in human sera, there is no such thing as anti-M or anti-N to be found in man. These antisera have therefore to be made; and these, to be of use at all, have to be highly agglutinating and rigorously specific. That this is a matter for highly specialized laboratories can be seen in the fact that in the whole world there are only three or four laboratories which prepare these antisera and consider them worthy of distributing.

It is a matter of immunizing rabbits with M and N group human sera. Here the first difficulty is met with. Dozens of sera may have to be tried, and dozens of rabbits have to be injected weekly, extending over months, before a serum worthy of being preserved may be discovered. Not more than one out of ten rabbits thus treated can be expected to give satisfactory antiserum. Such a serum has then to be treated, in order to remove any aspecific antibodies, by bringing it into contact with the cells of the blood with which the rabbit was originally injected.

During this process it is very likely that a certain agglutination takes place to render many sera inactive.

And even when a satisfactory serum has been prepared, its constancy cannot be guaranteed, even when kept in the refrigerator. Its titre may decline rapidly, even within a few days. It is therefore necessary to have available more than one of these antisera for control purposes. One should also have the facilities to have results verified in other laboratories where the test is performed as a routine.

It will thus be seen that the difficulties in the preparation of the test sera M and N bristles with such difficulties that its preparation in Australia will be out of the question for years. On the other hand, to obtain the sera from overseas is quite dangerous, on account of the impossibility of being able to guarantee their efficiency and of finding controls.

And let us remember the old saying about the gallows: "It is better that two guilty ones go free, than that one innocent man be hanged."

Yours, etc.,
ALFRED E. FINCKH.

227, Macquarie Street,
Sydney,
June 29, 1942.

POST-OPERATIVE TREATMENT OF MASTOID OPERATIONS.

SIR: Dr. Blashki's letter in your issue of July 11 contains controversial statements of such high calibre that I feel I cannot allow them to go unchallenged.

We are asked to believe that "the classical type of radical operation is a dead letter, and that only the conservative type of operation with retention of the ossicles is desirable", and I am so incredulous as to wonder if any typographical errors have occurred. If not, I can only say that I think this is not merely an unfortunate expression of opinion, but one that might be harmful if generally accepted.

In considering this subject, one must realize that in the majority of cases the factor determining the question of operation or conservative treatment is the presence or absence of cholesteatoma. It is, I think, no overstatement to say that a large proportion of chronic discharging ears are cholesteatomatous. In my experience, the middle ear cleft is very, very frequently invaded in these cases, and retention of the membrane and ossicles (if by chance they should be relatively intact) simply forms an infected pocket which persists and defeats the object of the operation, that is, a dry ear.

We read, however, that "since the only types of chronic otitis which require operating have the middle ear more or less intact, there can be no reason for seriously interfering with its contents". When one starts off by postulating a fallacy, it is possible to prove almost anything; and I submit that the first part of this sentence is definitely opposed to fact. I have always urged conservatism in the surgery of our specialty, and for this reason have performed a large number of operations on ears with chronic infection by the method advocated by Dr. Blashki (that is, retention of membrane and ossicles), with or without plastic flaps—very frequently to my sorrow. The flap operation was sponsored by Heath and bears his name, and I do not deny that it has its uses in selected cases; but the fact that this operation has caused so much controversy in the past is, I consider, a proof of its limitations.

Also on many occasions I have been forced to convert a conservative operation into a radical one, and in others have subsequently regretted that I had not performed a radical operation in the first place. The middle ear does remain a constant source of infection; even an atticotomy is no guarantee of success. Also labyrinthine fistulæ and (or) facial nerve involvement frequently occur in these chronic cases. Does Dr. Blashki ask us to treat these by his conservative method? I feel sure he does not.

Another point which I would stress is that, provided the inner ear is not affected, the removal of drum and ossicles (already necessarily damaged by disease in most cases)—this opinion, you will note, is diametrically opposed to Dr. Blashki's—not only has no detrimental effect on the hearing, but actually, in the majority of cases, improves it. This is doubtless brought about by the cleaning out of the middle ear cleft and removal of occluding debris and retained secretions.

In conclusion, let me state my conviction that the classical radical operation will never die, though there may be minor modifications in technique.

Yours, etc.,
HUBERT M. JAY.

North Terrace,
Adelaide,
July 17, 1942.

ESSENTIAL HYPERTENSION.

SIR: In a letter in your issue of June 13 Dr. Shallard lays great stress on what has been recently styled "Essential Hypertension", the definition for such being that no demonstrable cause can be found. In other words, every case of hypertension that any individual cannot find a cause for is to be classified as "Essential Hypertension". This is a very elastic definition and depends a great deal on the individual's powers of hunting out infections. Having been in practice some forty-five years and a good many of them in charge of large hospital medical clinics, I have never been able to satisfy myself of this type of hypertension being a separate entity. Pathogenesis in the main follows a general plan, inflammatory reactions followed by fibrosis, degenerative changes, irritative lesions causing hypertrophy and allergic reactions, all of which can be and usually are due to presence of organisms or their toxins. It is not logical to assume that we can breed organisms in our bodies without some of our tissues suffering injury from their toxins; this injury will fall in a great measure on the peripheral vascular field. Take a simple case of an individual with one dead tooth or a chronic sinus infection and who incidently has a high blood pressure. How are you going to demonstrate the relationship between the two? The only way is to see what happens when the infection is removed or inject a dog for ten years with small doses of bacterial toxin and see the result. The vascular changes which in some cases are more or less generalized, in others are more pronounced in the kidneys, but in all there will be found some kidney changes, which are of the type known as chronic interstitial nephritis, with gradual occlusion of the blood vessels, the bacterial origin of which Dr. Shallard says is mere conjecture. That may be so, but it is the most sane and likely one and can be proved by the individual himself if he has patience enough to follow out the results of treatment laid down on these lines. When we consider the matter of syphilitic endarteritis, coronary disease and obliterating arteritis, many cases of which have been shown to be the result of direct invasion by organisms, the conjecture that the arterial changes in chronic interstitial nephritis being due to bacterial toxins is not so shallow after all. In the practice of our profession, our first duty is to cure our patients by whatever means we can best do so, and not to refuse to use any treatment because some experiment or other has not been proved on a dog.

In writing these letters my aim has been some constructive criticism which may help us to unravel the origin of these and other diseases, but for one to definitely exclude the possibility of bacterial toxins playing a large part in hyperpiesis, the origin of which the individual has been unable to elucidate, just does not seem right.

In support of my views on pathogenesis in general I will quote a paragraph from the April 18 issue of the *British Medical Journal*, page 500, "Modern Views on Bright's Disease". "By experiments based on the technique of Goldblatt these observers were able to show conclusively that hypertension not only may be caused by diminution of renal blood supply, but in turn actually leads to necrosis of arterioles in the kidney and elsewhere, which thus still further decreases the renal blood supply and aggravates the hypertension. This is the key to the understanding of the end-stages of so many forms of kidney disease. Acting in different ways and starting from different causes, they produce a gradual diminution in renal blood supply, which leads to hypertension and thus initiates the vicious circle. So nephritis, pyelonephritis, pregnancy, toxæmia, essential hypertension, polycystic kidney, and a number of other conditions may all present in their final stage a closely similar clinical picture—the so-called chronic interstitial nephritis of older authors."

Yours, etc.,
Sydney Pern.

Ballarat,
Victoria,
July 16, 1942.

DOCTORS AND THE DRINK TRAFFIC.

Sir: Dr. Nye has suggested a new method of attacking Australia's alcohol indulgence problem. His suggestion is to point out to the drinker how silly it is to drink. I suggest that it is because he is silly that he drinks.

It will take more than the medical profession to attempt a remedy for this instability and wildness. For the Australian is inclined to be very self-willed; the arm of the law would not appear to be strong in the matter; and the trade itself has developed a very efficient technique.

The matter reaches some significance when one considers that the rest of the world has delivered its judgement on our manners and methods by fixing the exchange rate at a twenty-five per cent. (25%) disadvantage against Australia.

Yours, etc.,
J. L. Whitworth.

Kalorama,
Victoria,
July 21, 1942.

AMYL-NITRITE IN THE TREATMENT OF ACUTE AERO-OTITIS MEDIA.

Sir: In your leading article on "Aviation and its Effect on the Ear" in the journal of July 18, 1942, you refer to the severe pain in the ears which is frequently occasioned in airmen by sudden changes in barometric pressure particularly by rapid descent.

For the information of your readers concerned with aviation, I shall be obliged if I may record particulars of two cases of this extremely painful condition which I successfully treated with amyl-nitrite inhalations in the year 1937, when I was in civilian medical charge of a Royal Air Force aerodrome in England.

Both cases occurred in young pilot officers who had dived rapidly from great heights.

In your article you state that, according to McGibbon, in rapid descents, the cartilaginous and membranous walls of the Eustachian tubes, in this condition, are pressed together and the lumen made impermeable. This occlusion, according to the same authority, may be relieved if treatment is begun at once, but if forced ventilation of the middle ear is not undertaken successfully, within one or two hours of the onset of symptoms, the tube becomes impermeable to air, even at high pressure, to fluid and to sounds. The condition, he adds, may take as long as fourteen weeks to resolve.

A similar condition, according to Lamport, is also met with in compressed-air workers and divers.[1]

On being confronted with the first of these cases, I was completely at a loss to know how to deal with it, as I had never seen or heard of any like case.

The pilot being in apparent agony, I at first thought of giving him a hypodermic injection of morphia, but since this, while likely to alleviate his pain, was unlikely to remove the underlying cause of his condition, it occurred to me that before giving him morphia I would be justified in trying the effect on him of an inhalation of amyl-nitrite, in the hope that the rapid and violent dilatation of the blood vessels of the head and neck induced by that drug would probably rectify the inequality of pressure on his *membrana tympani*, if due to passive congestion, which I concluded must be the underlying cause of his pain.

I accordingly gave him an inhalation of amyl-nitrite "Vaporole" minims 3 which to my great satisfaction afforded him immediate (and permanent) relief.

The second case was similar to the first, except that the patient in this instance required a second 3-minim capsule of amyl-nitrite to bring about the characteristic flushing of his face and neck with consequent relief.

My object in publishing details of these cases is the hope that those who are in a position to do so may try out amyl-nitrite inhalations in this condition, and if found satisfactory, that all airmen may in future be provided with capsules of this drug for use in similar emergencies.

Yours, etc.,
J. Walker Tomb, M.D.

Sydney,
July 27, 1942.

Reference.

[1] H. Lamport: "Maneuver for the Relief of Acute Aero-Otitis Media", *Journal of Aviation Medicine*, Volume XII, June, 1941, page 163.

Post-Graduate Work.

WINTER LECTURES AT SYDNEY.

The New South Wales Post-Graduate Committee announces that a course of winter lectures is being held at 4.30 p.m. each Monday afternoon at the Stawell Memorial Hall, 145, Macquarie Street, Sydney. There will be no charge for attendance at these lectures which are as follows:

Monday, August 10, 1942.—"Malaria", by Colonel Hamilton Fairley and Lieutenant-Colonel A. S. Walker. A film on "The Mosquito and Malaria" will be shown by courtesy of the Shell Company of Australia, Limited.

Monday, August 17, 1942.—Programme arranged by medical officers of the United States and Royal Australian Navies.

1. Surgeon Commander J. Flattery, R.A.N.: "Experiences Regarding Salt Deficiency Among Naval Personnel."
2. Surgeon Lieutenant J. E. Hughes, R.A.N.R.: "Some Remarks Concerning Treatment in Head Injuries."
3. Surgeon Lieutenant-Commander O. H. Alexander, Medical Corps, U.S.N.: "A Few Lessons from Pearl Harbour."
4. Surgeon Lieutenant-Commander James Flynn, R.A.N.R.: "Observations upon Matters Ocular."
5. Surgeon Lieutenant John Russell, R.A.N.R.: "Naval Casualties in the Pacific War Zone."

Monday, August 24, 1942.—"War Neuroses", by Captain A. J. M. Sinclair.

Monday, August 31, 1942.—A programme will be arranged by members of the 47th Station Hospital Unit, United States Army.

Monday, September 7, 1942.—A programme will be arranged by medical officers of the Royal Australian Air Force.

Monday, September 14, 1942.—Colonel W. Hailes has been invited to deliver a lecture on this date.

Monday, September 21, 1942.—"Dengue." Speakers to be arranged.

Monday, September 28, 1942.—Demonstration of clinical cases to be arranged by Lieutenant Commander Kempson Maddox and Squadron Leader A. J. Hood Stobo.

Monday, October 5, 1942.—A programme will be arranged by the staff of the 120th Special Hospital.

Applications for post-graduate instruction in any subject should be made to the Secretary of the Post-Graduate Committee, 145, Macquarie Street, Sydney. Telephone B 4606.

WEEK-END COURSE AT ARMIDALE, NEW SOUTH WALES.

A week-end course will be held on August 15 and 16, 1942, at the Literary Institute, Armidale, by the Northern District Medical Association in conjunction with the Second Fifth Australian General Hospital. The programme of the course will be as follows.

Saturday, August 15.

12 p.m.—"War Contributions to the Advance of Medical Practice", Lieutenant-Colonel A. S. Walker.

2 p.m.—"Recent Advances in the Study and Treatment of Rheumatoid Arthritis", Major Thomas McP. Brown, 118th General Hospital, United States Army.

3 p.m.—"Meningitis", Lieutenant-Colonel L. F. Dods.

4.30 p.m.—"American Methods in the Post-Operative Care of Patients", Captain Harris. B. Shumacker, junior, 118th General Hospital, United States Army.

5.15 p.m.—"Some Skin Diseases of General Medical Practice", Colonel J. C. Belisario.

8 p.m.—"The Clinical Use of Sulphonamides", Major Thomas McP. Brown.

Sunday, August 16.

9.30 a.m.—"Burns", Lieutenant-Colonel A. J. Murray.

10.15 a.m.—"Peptic Ulcer", Lieutenant-Colonel A. S. Walker.

11.30 a.m.—"The Prevention and Treatment of Tetanus", Captain Harris. B. Shumacker, junior.

2 p.m.—Visit to an Australian General Hospital.

The fee for the course will be £1 1s. There will be no charge for members of the Defence Forces. Those wishing to attend are especially invited, in order to facilitate the organization, to make application not later than August 12 to Dr. R. J. Jackson, Honorary Secretary, Northern District Medical Association, Armidale.

Naval, Military and Air Force.

CASUALTIES.

According to the casualty list received on July 29, 1942, Major C. R. Furner, A.A.M.C., Mayfield, New South Wales, and Major P. F. Murphy, A.A.M.C., Bellevue Hill, New South Wales, are reported to be missing abroad.

According to the casualty list received on July 31, 1942, Major R. H. Stevens, A.A.M.C., Kew, Victoria, and Captain J. D. Morris, A.A.M.C., Oakleigh, Victoria, are reported to be missing overseas.

According to the casualty list received on August 3, 1942, Captain T. Le Gay Brereton, A.A.M.C., Turramurra, New South Wales, Captain J. T. Finimore, A.A.M.C., Ipswich, Queensland, and Captain C. R. R. Huxtable, A.A.M.C., Southport, Queensland, are reported to be missing overseas.

Obituary.

MALCOLM TALBOT HAMILTON.

We regret to announce the death of Dr. Malcolm Talbot Hamilton, which occurred on July 24, 1942, at North Albert Park, Victoria.

GERALD ROBERT BALDWIN.

We regret to announce the death of Dr. Gerald Robert Baldwin, which occurred on July 8, 1942, at Glen Iris, Victoria.

Nominations and Elections.

The undermentioned have applied for election as members of the New South Wales Branch of the British Medical Association.

Greenwell, Colin Campbell, M.B., B.S., 1938 (Univ. Sydney) Royal Australian Air Force Section, 113th Australian General Hospital, Concord.

Rosenfeld, Israel (registered in accordance with the provisions of Section 17A of the *Medical Practitioners Act*, 1938-1939), District Hospital, Goulburn.

Storey, David Maxwell, M.B., B.S., 1942 (Univ. Sydney), Royal Prince Alfred Hospital, Camperdown.

The undermentioned has applied for election as a member of the Victorian Branch of the British Medical Association:

Stewart, Alan Benjamin, M.B., Ch.B., 1920 (Univ. Leeds), 531, St. George's Road, Thornbury, Victoria.

Diary for the Month.

Aug. 11.—New South Wales Branch, B.M.A.: Executive and Finance Committee.
Aug. 11.—Tasmanian Branch, B.M.A.: Branch.
Aug. 14.—Queensland Branch, B.M.A.: Council.
Aug. 18.—New South Wales Branch, B.M.A.: Ethics Committee.
Aug. 19.—Western Australian Branch, B.M.A.: Branch.
Aug. 20.—New South Wales Branch, B.M.A.: Clinical Meeting.
Aug. 25.—New South Wales Branch, B.M.A.: Medical Politics Committee.
Aug. 27.—New South Wales Branch, B.M.A.: Branch.
Aug. 27.—South Australian Branch, B.M.A.: Branch.
Aug. 28.—Queensland Branch, B.M.A.: Council.
Aug. 28.—Tasmanian Branch, B.M.A.: Council.
Sept. 1.—New South Wales Branch, B.M.A.: Organization and Science Committee.
Sept. 2.—Western Australian Branch, B.M.A.: Council.
Sept. 3.—New South Wales Branch, B.M.A.: Special Groups Committee.
Sept. 3.—South Australian Branch, B.M.A.: Council.
Sept. 4.—Queensland Branch, B.M.A.: Branch — Jackson Lecture.

Medical Appointments: Important Notice.

Medical practitioners are requested not to apply for any appointment mentioned below without having first communicated with the Honorary Secretary of the Branch concerned, or with the Medical Secretary of the British Medical Association, Tavistock Square, London, W.C.1.

New South Wales Branch (Honorary Secretary, 135, Macquarie Street, Sydney): Australian Natives' Association; Ashfield and District United Friendly Societies' Dispensary; Balmain United Friendly Societies' Dispensary; Leichhardt and Petersham United Friendly Societies' Dispensary; Manchester Unity Medical and Dispensing Institute, Oxford Street, Sydney; North Sydney Friendly Societies' Dispensary Limited; People's Prudential Assurance Company Limited; Phœnix Mutual Provident Society.

Victorian Branch (Honorary Secretary, Medical Society Hall, East Melbourne): Associated Medical Services Limited; all Institutes or Medical Dispensaries; Australian Prudential Association, Proprietary, Limited; Federated Mutual Medical Benefit Society; Mutual National Provident Club; National Provident Association; Hospital or other appointments outside Victoria.

Queensland Branch (Honorary Secretary, B.M.A. House, 225, Wickham Terrace, Brisbane, B.17): Brisbane Associated Friendly Societies' Medical Institute; Bundaberg Medical Institute. Members accepting LODGE appointments and those desiring to accept appointments to any COUNTRY HOSPITAL or position outside Australia are advised, in their own interests, to submit a copy of their Agreement to the Council before signing.

South Australian Branch (Honorary Secretary, 178, North Terrace, Adelaide): All Lodge appointments in South Australia; all Contract Practice appointments in South Australia.

Western Australian Branch (Honorary Secretary, 205, Saint George's Terrace, Perth): Wiluna Hospital; all Contract Practice appointments in Western Australia.

Editorial Notices.

Manuscripts forwarded to the office of this journal cannot under any circumstances be returned. Original articles forwarded for publication are understood to be offered to The Medical Journal of Australia alone, unless the contrary be stated.

All communications should be addressed to the Editor, The Medical Journal of Australia, The Printing House, Seamer Street, Glebe, New South Wales (Telephones: MW 2651-2.)

Members and subscribers are requested to notify the Manager, The Medical Journal of Australia, Seamer Street, Glebe, New South Wales, without delay, of any irregularity in the delivery of this journal. The management cannot accept any responsibility unless such a notification is received within one month.

Subscription Rates.—Medical students and others not receiving The Medical Journal of Australia in virtue of membership of the Branches of the British Medical Association in the Commonwealth can become subscribers to the journal by applying to the Manager or through the usual agents and booksellers. Subscriptions can commence at the beginning of any quarter and are renewable on December 31. The rates are £2 for Australia and £2 5s. abroad *per annum* payable in advance.